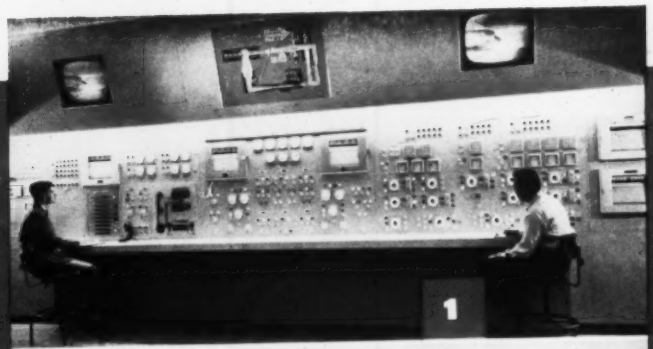
INSTRUMENTS and AUTOMATION



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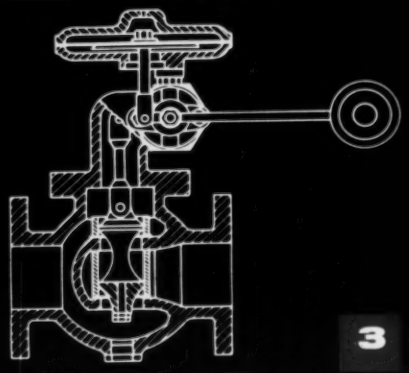

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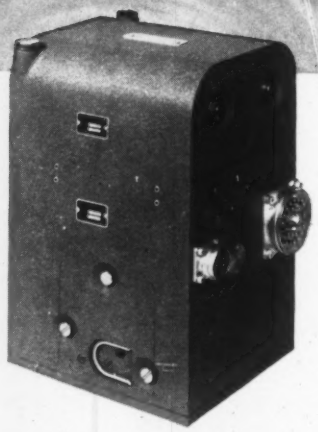
MAY 1957

Including: Instrument Manufacturing • The Journal of the ISA • Simulation Council Newsletter

engineered to ride a rocket



THE MIDWESTERN 561 RECORDING OSCILLOGRAPH

561 SPECIFICATIONS

Weight	15½ lbs.
Dimensions	6-11/32" x 5-3/16" x 9-3/16"
No. of Channels	14
Magazine Capacity	95' DuPont Lino Writ #4
Recording Speed Range	0.5" to 80" per sec.
Trace Identification	Beam Interrupter Type
Constant Acceleration	Above 25 Gravities
Shock Accelerations	Above 1500 Gravities for 20 Milliseconds
Temperature	—65°F to +165°F
Altitude	Up to 100,000' above sea level
Power Requirements	28 volts DC, 12 Amperes Maximum
Connectors:	
Power	WK-5-32S
Galvanometer	FK-C32-32S

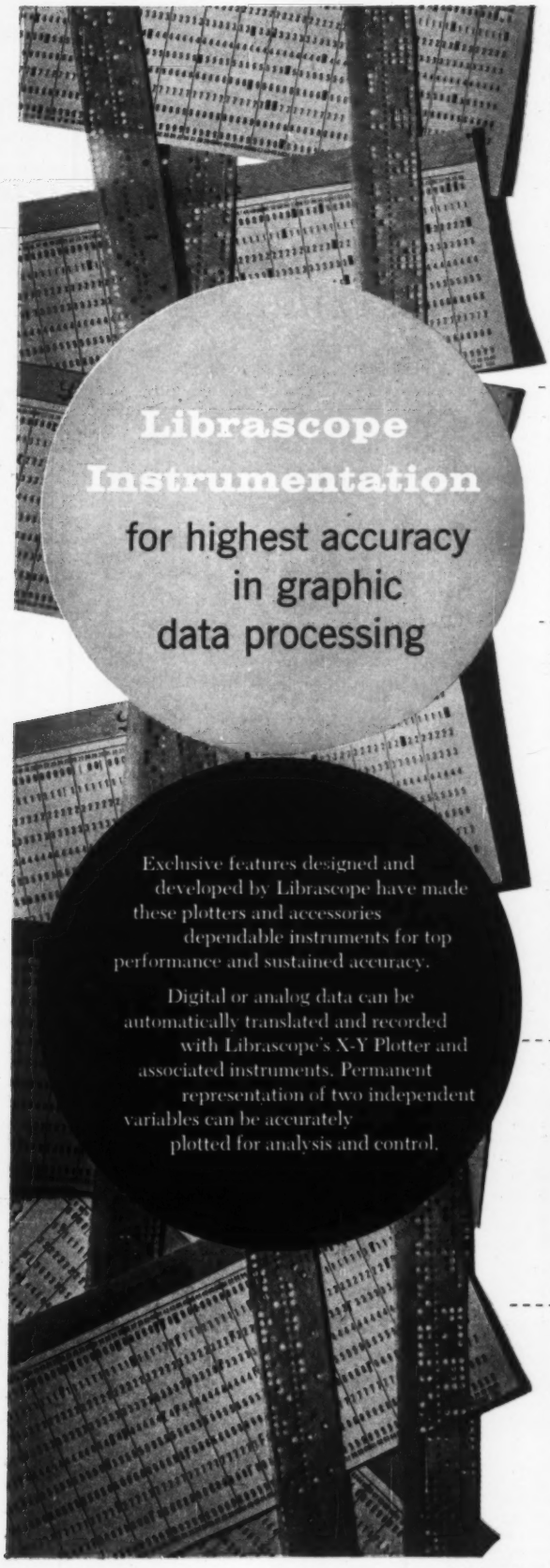
This new recording oscillograph now makes it possible to eliminate costly telemetering equipment in missile, torpedo or similar testing. Its miniature size, extreme ruggedness and high recording speeds allow it to be installed directly in the test vehicle, where it will record all data and will withstand the high shocks and accelerations associated with the test.

MIDWESTERN INSTRUMENTS

MI

41st and Sheridan Road • Tulsa, Okla.

For more information circle **1** on inquiry card.



Librascope Instrumentation

for highest accuracy in graphic data processing

Exclusive features designed and developed by Librascope have made these plotters and accessories dependable instruments for top performance and sustained accuracy.

Digital or analog data can be automatically translated and recorded with Librascope's X-Y Plotter and associated instruments. Permanent representation of two independent variables can be accurately plotted for analysis and control.

MODEL 200-B X-Y PLOTTER, used for DC signal input, has full-scale sensitivities of five millivolts, and an input impedance of 1,000 megohms. Utilizing standard reference cells, this model provides drift-free operation. Available external reference voltages may be substituted. Quick interchangeability of input sections is provided. Continuous or point plotting... Rack or case mounted.

MODEL 200-A uses an input of 10,000 ohm resistance potentiometers as an input translator providing 10 to 1 scale expansion and origin positioning. Available standard digital input accessories are essentially inputs of this type. Any resistance potentiometer will provide an analog input for this configuration. Continuous or point plotting... Rack or case mounted.

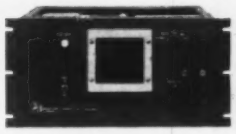
LIBRASCOPE XY DECIMAL KEYBOARD —This keyboard consists of a three-decimal bank for each axis with associated plus-minus keys. Depressing of the plotting bar initiates plot and clears keyboard automatically. Manual "clear" button is also provided. This unit features Librascope-developed positive-action non-sticking, self-wiping contacts.

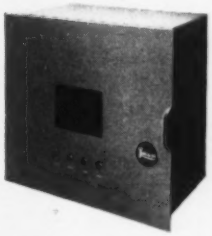
LIBRASCOPE BINARY CONVERTER, MODEL 252 consists of two banks of relays and precision resistors simulating a precision potentiometer. The resistors weight the relays in straight binary so that each bank serves as an input to one axis of the XY plotter. Total resistance is 10,000 ohms per bank. Relays within the converter control the plot cycle.

Mounting: Standard RCA, RMA rack mounts.

LIBRASCOPE PUNCHED CARD CONVERTER —This relay-operated converter accepts three-decimal digit and sign, two channel, IBM punched card information and converts it to analog form for input to XY plotters. Cards can be manually fed through the IBM reading brushes one at a time or automatically read at rates to 50 cards per minute with an accuracy of 0.1%.

Mounting: Standard RCA or RMA rack mounts or in case.





LIBRASCOPE PUNCHED TAPE CONVERTER operates from punched tape reader. Can be modified to operate with any digital computers furnishing a punched tape output. If printed listing desired, unit may be operated from tape-actuated typewriter, such as the Flexowriter. Programming need not be specified on tape. Sequence operation. A particular tape may be programmed to accommodate various tape formats.

Accuracy 0.1%.

Career opportunities exist at Librascope for qualified engineers, physicists and mathematicians. Learn about Librascope's new "Creative Project Development Teams." Contact Glenn Seltzer, Employment Manager.

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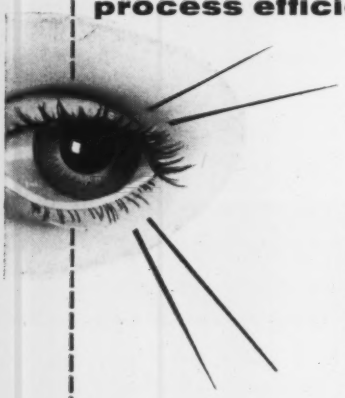
LIBRASCOPE

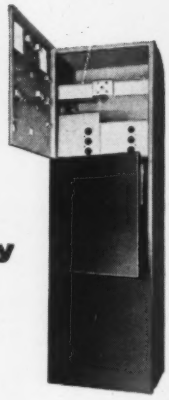
Librascope, Inc., 808 Western Ave., Glendale, Calif.

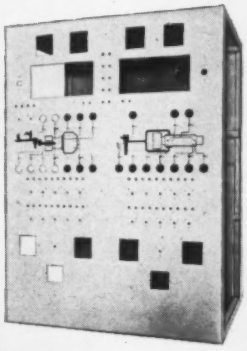
For more information circle **2** on inquiry card.

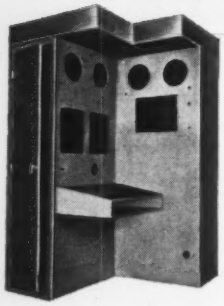
FALSTROM

"VISIONEERED" panels and control boards help improve process efficiency









Falstrom "visioneered" steel instrument and control boards, graphic panels, consoles, cubicles and cabinets are made exactly to your designs and specifications so as to achieve better functional integration of your instruments, for easier supervision with less fatigue. Falstrom fabrications are made to close tolerances and because of Falstrom's large facilities and modern equipment, no need to sacrifice or compromise on your original specifications and intentions.

Falstrom's "visioneered" construction gives you exactly what you envisage. Put Falstrom "visioneering" to work for you in accurate mountings of any size, in any metal—at low cost.

Write for Falstrom catalog of standard panels and control boards 143A or send prints and requirements for prompt estimate.

FALSTROM

FALSTROM COMPANY

92 Falstrom Court • Passaic, New Jersey

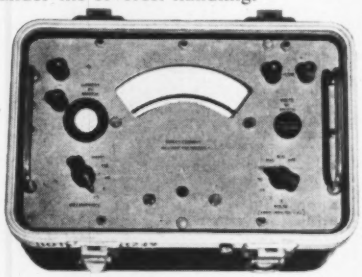
For more information circle **3** on inquiry card.

SENSITIVE RESEARCH

First IN **ELECTRICAL INSTRUMENT ENGINEERING**

NEW!
RUGGEDIZED INSTRUMENTS

"Diamond Pivots and shock mounted sapphire jewels" are now available in *all* SRIC instruments. This unique assembly makes even the most ultra-sensitive instrument a *rugged reliable* indicator that will stand up under the severest handling.



Ruggedized Waterproof D. C. Polyranger

Multirange current and voltage instrument designed to withstand a 3 foot drop onto a concrete floor. Basic sensitivity is 50 microamperes and 20,000 ohms per volt. Accuracy .5%. Special correspondence invited on your application.

NEW!
PANEL INSTRUMENTS

EDGEWISE PANEL INSTRUMENT with *long* 7.1" hand drawn mirrored scale, and an *accuracy of* .25%. AC and DC, single and multirange instruments for the measurement of current, voltage, power, frequency, and flux density.

SENSITIVE RESEARCH INSTRUMENT CORPORATION

NEW ROCHELLE, N. Y.

Symbol of Quality

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INSTRUMENTS and AUTOMATION

Volume 30, No. 5
May 1957

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THE MAGAZINE OF INSTRUMENTATION AND AUTOMATIC CONTROL SINCE JANUARY 1928

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Accurate, Fast Acting, Frequency Type Telemeter for Transmission over Wire Lines, Microwave, and Power Line Carrier

Accurate HIGH-SPEED Continuous Telemeter for VOLTS AMPS WATTS VARS ETC.

Built-in Self-Calibrating Circuit

The Model 1025 Telemeter Transmitter converts DC mv from thermal converters, etc., to 10-30 cps which frequency modulates a built-in audio tone channel. AC 10 to 30 cps or relay outputs are also available. Receiver detects and demodulates transmitted signal, generating a DC mv for operation of recorders or indicating instruments. Up to 45 telemeters can be multiplexed.

Any communication link, including power line carrier, microwave or wire line may be used.

Over-all accuracy is 1% with a response speed of 1 second. Equipment features a built-in calibration circuit for 10% and 90% receiver check, and 10 cps and 30 cps transmitter check.

Any quantity which may be converted into a DC millivoltage or will operate a slidewire may be telemetered.

WE CAN HELP YOU
Our Applications Department is ready to assist you in your control, telemetering or communications problem. Phone DEerfield 4-3100.

Write for Technical and Application Data.

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For more information circle **5** on inquiry card.

Letters to the editor

Editor I&A:

Regarding the article "Uncommon Uses for Common Digital Computers" by Martin L. Klein, while we understand that this article was written with tongue-in-cheek, there are several items mentioned in it which are incorrect.

First, the section under "Computers and Predictions" where Mr. Klein states "The most significant step (backwards) developed during the 1952 Presidential election when a group attempted a running prediction of election results. The circumstances surrounding this enduring 'goof' are shrouded by conflicting accounts which variously place the responsibility on Univac, the Lockheed Corporation, the Metropolitan Lighting District and/or the National Broadcasting Company."

As you are, no doubt, aware, the computer predicted the final result of the 1952 election quite early in the evening, and this prediction came very close to the actual result . . . The Lockheed Corporation had no connection with the 1952 election, and at the time of the election did not have an electronic computer installed. The Metropolitan Lighting District was certainly not involved and the Univac was shown on the Columbia Broadcasting System, not the National Broadcasting System.

In the section sub-titled "Computers and Humanities" Mr. Klein discusses the use of the computer in the field of Biblical investigation. Mr. Klein refers to the use of Univac and the compilation of a complete Concordance of the Holy Bible. This Concordance consisted of an alphabetical listing of the location of every word. This was a most important project and the result has been most gratifying. I know that Mr. Klein was treating the over-all subject rather humorously, but I know you will also agree that these two projects point up the versatility and capability of the Univac system and have gone a long way towards giving the computer the over-all prestige it now enjoys.

T. R. Cott
Remington Rand

Yes, Martin Klein had "tongue-in-cheek" because he, as much as any one single person in the field, has been responsible for the "uncommon" uses. His main point was simply that newspaper publicity has over-emphasized the dramatic unorthodox applications of computers—and that we engineers, at least, should not lose perspective. We are glad to set the record straight regarding the 1952 election and the Bible Concordance. The author replies as follows:

I read Mr. Cotts comments with great interest. The corrections, and there are probably more, are accepted without argument.

My only statement would be "You buttered your bread, now sleep in it."

Martin Klein

Editor I&A:

The following article appeared in your February issue: "Basic Analysis Methods for Nonlinear Control Systems," by T. M. Stout. The author is listed as employed by the Schlumberger Instrument Company, whereas he left the company over a year ago to join the Ramo-Wooldridge Corporation.

A. R. Aikman
Schlumberger Well Surveying Corp.

Editor I&A:

In a recent Letter to the Editor, you stated that you were starting a Home-Study course on Basic Instrumentation. I want to take this course and I would appreciate your sending me information regarding it.

Our shop receives two copies monthly of "Instruments and Automation" through a Navy subscription, and believe me we regard *I&A* as the "Best".

W. F. Noyes
P.W.C. U.S.N.
San Francisco, Calif.

The home-study questions on basic instrumentation are still in preparation, and will begin in about 2 or 3 months. They will appear monthly in *INSTRUMENTS and AUTOMATION*. Thanks for the kind words.

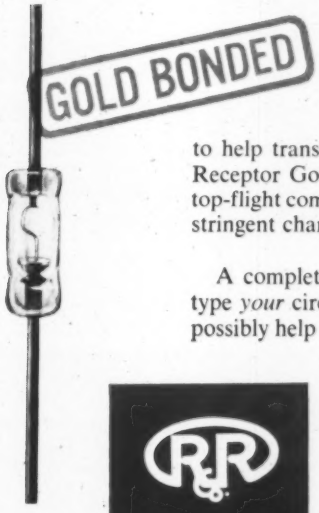
Editor, I&A:

As I am now writing the book *Computer Primer* for Ronald Press Co., for high school and undergraduate level, I am sympathetic to your proposal for a high-school course in Automation and Industrial Technology.

George H. Amber
Detroit, Mich.

Making drawing board dreams come true!

Radio Receptor



Germanium Diodes

You electronic engineers show limitless imagination and ingenuity, but to help translate ideas into reality you need extra special components, such as Radio Receptor Gold Bonded Diodes. Right now they are being used successfully by many top-flight companies whose circuits require high forward conductance coupled with other stringent characteristics – and the ability to take a beating under grueling conditions.

A complete range of RRco. diode types is available – and if you haven't found the type *your* circuit calls for, no doubt we can make it specially for you. So, if diodes can possibly help your project, consult our engineers without obligation. Write Dept. A-5.

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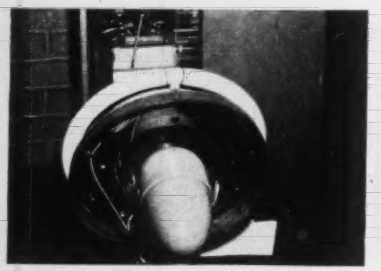
CLOSED-CIRCUIT TV
in action

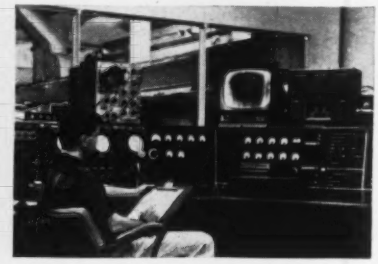
See how industry is solving tough problems
visually*—with GPL *ii-TV*

Quick record reference via *ii-TV* permits concentration of records in one area, saves this user $30,000 a year. GPL system is simple enough for anyone to operate.

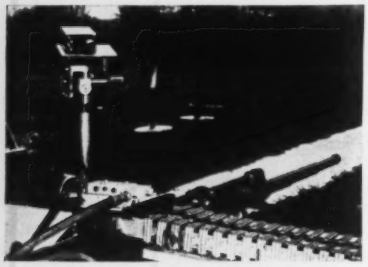
Hard-to-see actions, as in the bouncing under-chassis of GM cars in road test, *above*, can now be viewed. Standard GPL TV camera takes hard knocks in stride.



Monitoring distant meter saves this manufacturer substantial sums in electric bills by avoiding peak loads. Reliable, remotely located TV camera by GPL needs no tending.



Observer is safe when dangerous operations, like this one involving radiation at Brookhaven National Laboratory, are seen through sharp pictures of GPL camera.



Even bone-shattering concussions can't disturb perfect pictures of GPL's Ruggedized camera, designed specifically for most severe applications.

Basic *ii-TV* system is finest, most dependable; costs less than medium-priced car. Mobile GPL TV Projector gives wall-size pictures 300% brighter than any other.

SEE *ii-TV FOR YOURSELF**

For further details, or demonstration of this precision-engineered system in your own office or plant by local GPL representative, write on your letterhead to Mr. N. M. Marshall, Sales Manager, General Precision Laboratory Incorporated, 61 Bedford Road, Pleasantville, N. Y.

*GPL's *industrial-institutional TV* system.

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LETTERS —CONTINUED

Editor, I&A:

Your remarks re Automation seem to make a good deal of sense. In a free enterprise, all producers would seem to try to produce by the most efficient method if they were to compete with others making the same items. Therefore, a slight trend toward Automation might be inherent and expected.

Noting the various conferences on Automation, with the implication that there may be some great economic danger, I have often wondered what everyone is getting excited about . . .

Harlan R. Hansen
Hansen Electronics Co.

Editor, I&A:

Publication of my letter "Standardizing of Instruments for Rack Mounting," and some of the answers, were appreciated very much . . .

There has been considerable local interest in the subject.

Keep up the good work on a good instrument magazine.

Harry G. Bangerter
Whittier, Calif.

Editor, I&A:

I am a recent subscriber but already am well aware of the great coverage of the instrumentation and automation field to be found in your publication. *Instruments and Automation* is, for me, the greatest amount of practical education for the least amount of money! You may quote me. North American Aviation employs me as a Research Engineer to instrument surface control servo systems.

Andreas B. Hansen
Westerville, Ohio.

Editor, I&A:

I am an instrument maker working for Bendix Aviation in Teterboro, New Jersey, and have been a subscriber to *Instruments* for about ten years.

Recently I have been placed in charge of tests and maintenance of what our plant calls the spin stands.

At present we have two stands driven by an air turbine to speeds of 65,000 R.P.M.; our engineering dept. is designing two new stands for 100,000 R.P.M. They are used to test turbine compressors and gyro wheels before assembly into various aircraft components.

It is sometimes necessary to test a wheel to destruction. I would like to

Askania Regulator Company NEWS

Automatic Controls for Edge Position and Thickness, Flow, Pressure, Ratio and Combustion

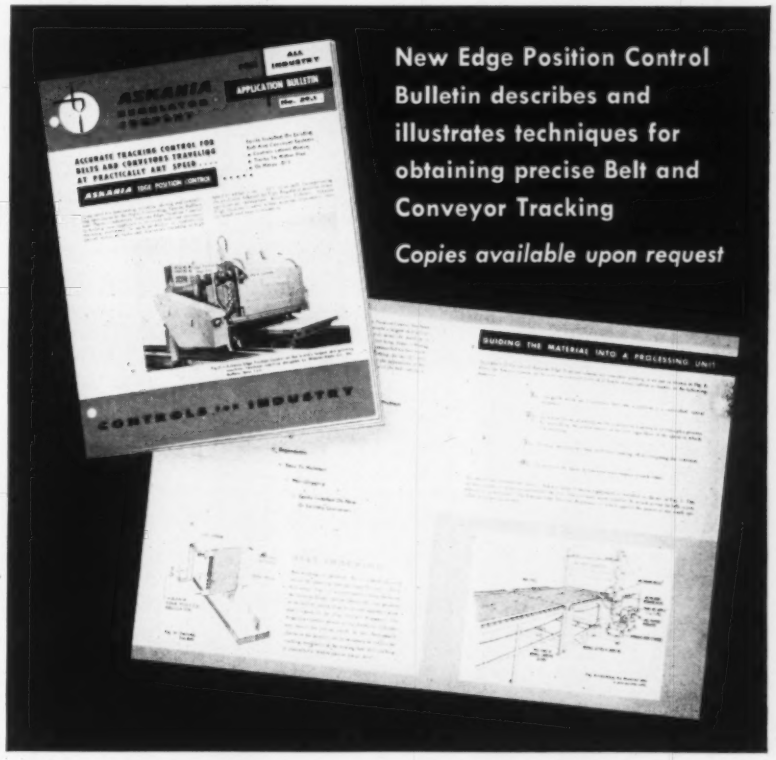
Bothered by LATERAL WEAVE of your Belts and Conveyors?

New information on Belt and Conveyor Tracking is provided in ASKANIA Regulator Application Bulletin #39.1. This bulletin is now available to anyone interested in:

1. **How to automatically control edge position when:**
   - A. Carrying material into a processing unit by means of a conveyor belt so as to deliver it at a specific lateral position into the unit.
   - B. Lateral weave of belt or conveyor must be eliminated so as to keep the material that it is carrying from falling off.
   - C. Tracking is a problem.
   - D. Lateral weave of belt or conveyor must be eliminated to permit maximum speed of operation...and/or prevent the belt itself from working off the roller.
2. **How to guide belt or conveyor at intermediate points or at other positions.**
3. WHAT makes the ASKANIA EDGE POSITION CONTROL the most effective device for eliminating lateral weave of even the highest speed belts and conveyors; easy to install and maintain; readily applicable to practically any belt or conveyor.

For example, the new bulletin diagrammatically illustrates:

- How to obtain precise tracking of high speed belts
- How to guide material into a processing unit
- How to position an intermediate steering roller to guide the belt in process



New Edge Position Control Bulletin describes and illustrates techniques for obtaining precise Belt and Conveyor Tracking

Copies available upon request

Sound, Practical Operation

Just check the Askania Edge Control advantages, listed below, which are completely described in bulletin No. 39.1. They explain why Askania Edge Position Controls provide consistently accurate belt tracking with a minimum of installation and maintenance. Askania Edge Position Controls are:

1. Non-contact—won't damage the edge of the belt or conveyor
2. Amazingly easy to install
3. Easily adaptable to *new* or *existing* machinery
4. Powerful—can position the heaviest rollers
5. Always dependable
6. Almost maintenance-free

Economy—Versatility

Bulletin No. 39.1 points out why and how these edge position controls

- Save you time and money
- Eliminate trial and error
- Permits higher operating speeds

Answers your questions

You'll probably find just the answers you need to solve your own specific belt or conveyor tracking problems in Bulletin #39.1. SEND FOR YOUR COPY TODAY TO ASKANIA REGULATOR COMPANY, 266 E. Ontario St., Chicago 11.

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"CONTROLS FOR INDUSTRY"
HYDRAULIC, ELECTRONIC CONTROLS & SERVOS, GENERAL SYSTEMS, ENGINEERING & COMPUTER SERVICE, VALVE ACTUATORS & CYLINDERS

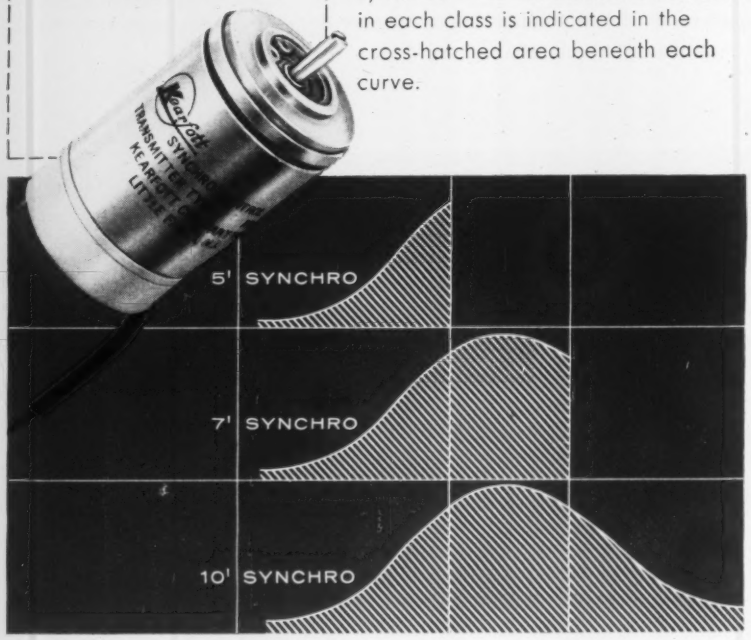
A SUBSIDIARY OF GPE

For more information circle **8** on inquiry card.

BUILT TO THE ACCURACY YOU REQUIRE

Kearfott Series R900 Synchros

. . . are not selected, but are built to the specific degree of accuracy required. The accuracy of each class and the distribution of errors within each class, is a function of rigid quality control. The curves below indicate the degree of accuracy of three classes of synchros. The distribution of errors in each class is indicated in the cross-hatched area beneath each curve.



Kearfott Series R900 Synchros are characterized by high accuracy, corrosion resistance and new high temperature stability. Units available for early delivery.

KEARFOTT COMPONENTS INCLUDE:

Gyros, Servo Motors, Synchros, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Indicators and other Electrical and Mechanical Components. Kearfott Systems include Directional Gyro Compass Systems, Three Gyro Stable Platform Systems and Inertial Navigational Systems.

Send for bulletin giving data of components of interest to you.

Kearfott

A SUBSIDIARY OF GPE

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.

Sales and Engineering Offices: 1378 Main Avenue, Clifton, N. J.
Midwest Office: 188 W. Randolph Street, Chicago, Ill. South Central Office: 6115 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

For more information circle 9 on inquiry card.

LETTERS—CONTINUED

acquire background information on such things as static balancing, dynamic balancing, and high speed bearings. Also the design of centrifuges.

I have quite a magazine collection of *Instruments & Automation*. If you could tell me what magazines have what articles I would appreciate it. I have already started to look through them, but a list would help a lot.

I would also like to get other information or literature that might be available.

Ernest V. Aspden
New Jersey

Our annual index for each year gives a long list of such references. In addition, see articles: (1) "G-Accelerator" by Ralph Brown, Genisco, Inc., page 1513, *I&A*, September '55; (2) "Dynamic Balancing" by S. A. Rybb, page 2422, *I&A*, December '56; (3) "Dynamic Balancing Machine", page 1670, *I&A*, August '56; (4) "Vibration Calibrator," by D. L. Schacher, *I&A*, March 1957; (5) New Product descriptions cataloged in the Annual Index—look under "Balancing," "Dynamic Balancer," etc. (6) Look also in the *Handbook of Measurement and Control* under "Speed Measurement and Control." The articles mentioned also contain further references and bibliography.

Editor, I&A:

The Article "Myths of Automation" in February issue of *Instruments and Automation* interested me considerably. It covers a lot of ground with on-the-spot observations, and clearly debunks many of the irresponsible claims advanced under the yet unfathomable and panacean area of automation. It is high time that some one in authority should take an unbiased, cool view of all this excitement, and Mr. Bright has done that in a convincing way.

Congratulations.

A. T. Gaudreau
Westport, Conn.

Editor, I&A:

Your new format and improved contents have made *I&A* a darn fine magazine. I've gone so far as to recommend that the technicians and

engineers working for me subscribe. It is a better mag than the new competition, which is too theoretical, with seldom a practical documented system described. Nothing irks the busy engineer more than description of a system which he would like to use, but no information on material, etc.

Alvin B. Kaufman
Los Angeles, Calif.

Compliments from the real experts in the field of technical writing are more than compliments.

Editor, I&A:

Your February editorial comment shows a good sense of value and adequately expresses the developments of 1956. Your comments relative to the analog computer field provide a capsule summary.

Bob Lowry
Goodyear Aircraft Corp.

Editor, I&A:

To me, the most valuable part of any periodical is the new products section. I like very much not only your complete coverage but the way you have grouped all new products of a similar nature. Naturally, many of the new products are not of interest to personnel in my company, and it helps to be able to pass over these uninteresting news releases in order to get to the meat of what is most important to us.

Another section of I&A that I like very much is "Trends." In order to be able to recognize the handwriting on the wall, we have to keep abreast of changes in attitude and equipment. The manner in which "Trends" is presented—that is, condensed and easily read—is very valuable in helping to pinpoint information.

P. M. Hankison
Hankison Corporation

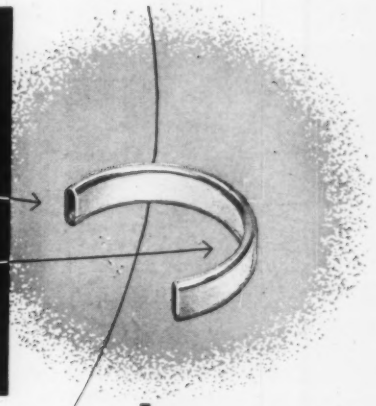
Editor, I&A:

Enclosed is a bulletin on this equipment which should make fine review material for a certainly fine magazine.

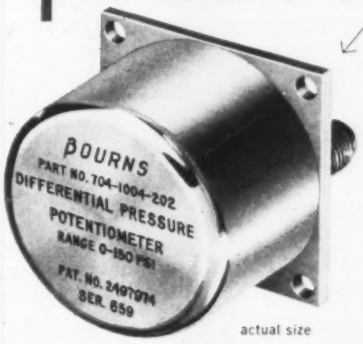
J. B. Sheehan
Exhibit Manager
B-I-F Industries, Inc.

This is how you get your "manufacturers' literature" material.

BOURNS
new
Bourdon tube



pressure transducers



actual size

—a complete line designed for high range—with stainless steel or beryllium copper construction.

Bourns—designer and manufacturer of its own Bourdon tubes—now brings this proved component to absolute and differential pressure potentiometers. Three instrument models are provided for an extensive range of applications.

Model 704
Differential Pressure Potentiometer—*for corrosive fluids*
This unit has a stainless steel Bourdon tube and fittings, to withstand fuming nitric acid and other corrosive fluids. All mechanical joints are Heli-arc welded. The instrument will measure differential pressure between two high pressure sources.

Model 705
Absolute Pressure Potentiometer
This absolute pressure potentiometer measures pressures in ranges of 0-100 to 0-1000 psia—extending the range of Bourns Aneroid Capsule instruments.

Model 706
Differential Pressure Potentiometer—*for non-corrosive fluids*
The Bourdon tube in this high range instrument is made of berryllium copper for use with non-corrosive fluids. With the low pressure port vented to the atmosphere, this unit can be used as a gage pressure instrument.

All models have a durable stainless steel case... compact configuration... excellent linearity, resolution and hysteresis. The rugged linkage system and Bourdon tube assembly provide excellent shock, vibration and acceleration characteristics. All models are now in quantity production. Write for new literature.

COPR. BL

BOURNS LABORATORIES
General Offices: 6135 Magnolia Avenue Riverside, California
Plants: Riverside, California—Ames, Iowa

For more information circle **10** on inquiry card.

FACTS

about

NEW DEPARTURE BALL BEARINGS

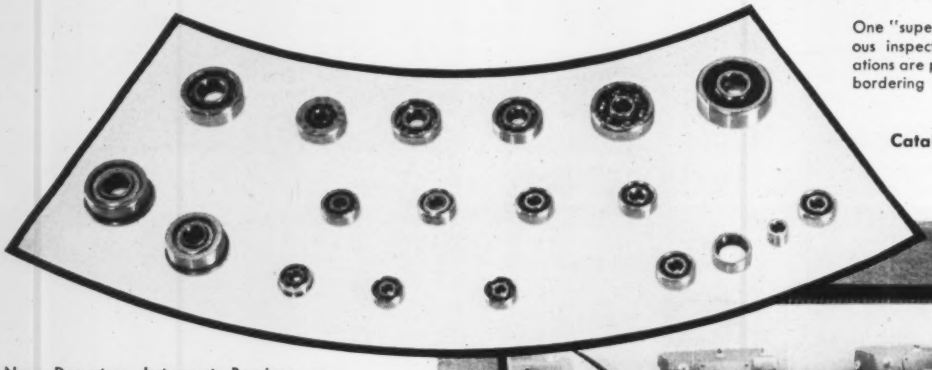
Super-Cleanliness for Super-Precision

New Departure ball bearings for highly sensitive instruments are so small . . . so super-precise . . . the tiniest speck of dust can adversely affect their performance. That's why extreme cleanliness governs throughout the assembly and final inspection of every single New Departure instrument bearing.

Such work is carried out in individual cabinets for each operation. Filtered, electronically cleaned air fed to each cabinet, flows outward to prevent the entrance of air-borne contaminants. In addition, the rooms in which the operations are performed are supplied with cleaned air that is pressurized to prevent inward flow at any entrance point.

One "super-clean" area where various inspection and assembly operations are performed under conditions bordering on surgical cleanliness.

Catalog sent upon request



New Departure Instrument Bearings are available in a wide range of types and sizes, including the extremely small miniature bearings of ⅜" diameter and smaller.

Torque testing instrument bearings in a "super-clean" area behind sterile shield.

SEE "WIDE WIDE WORLD"
SUNDAYS—NBC-TV

BALL BEARINGS MAKE GOOD PRODUCTS BETTER

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.

For more information circle 11 on inquiry card.

Inquiries

These inquiries, representing problems facing readers of **Instruments & Automation**, are published as a free service to our readers.

Capacitor Microphone

Researcher in Aeronautical Engineering Department of University seeks information on capacitor-pick-up microphone with a frequency response from 0.01 to 30 cps, and sensitive to pressure waves smaller than 5 microbars. A-217

Air Flow and Temperature

Manufacturer of air-conditioning sheet-metal equipment desires information on instruments to measure air flow and temperature in ducts. A-218

Test Equipment

Service company wishes to receive catalogs on dead-weight testers and other standard test equipment for pressure, vacuum, and temperature. A-219

Clutch, Sequential Memory Unit

Engineer in materials handling department is looking for small duplex machine clutches, solenoid or magnetically operated, for loads of approximately 100 in-lb.—He is also interested in information on a standard sequential memory system (of any kind) capable of operating a 10-station system of from 50 to 150 station selections per minute. A-220

Electrostatic Memories

Consulting engineer is interested in sources of supply for electrostatic memories and CR tubes. A-221

Plastic Material

Swedish engineer would like to get information on "plastic material with 80% sulphur, resistant to chemicals, and capable of bonding on brass" to form gaskets. A-222

Testing Equipment

Librarian of research department would like to get information on testing equipment and methods of inspection for lined containers. A-223

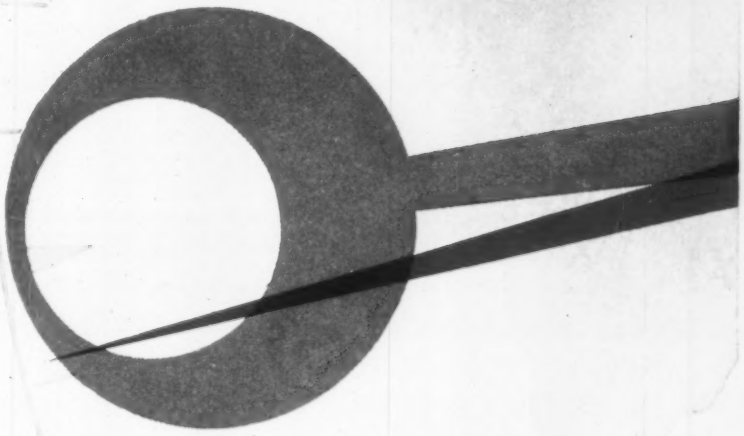
Small Ammeter

Consultant wants sources of supply for small ammeter with range 0-10 amps. A-224

INCOMPARABLE

USG®

PILOT



indicates set point and process variable at a glance!

plus . . .

- Standard proportional band 1-100% . . . also available to 150%.
- Proportional and differential gap actions easily selected with a screwdriver.
- Manual reset readily accessible. Automatic reset optional.
- Compact—8⅝" square x 4" deep.
- Pneumatic feedback circuit with sensitivity of 1/10% and repeatability of ½%.
- Available in a variety of temperature ranges; pressure ranges from 0-30" H_2O to 0-10,000 psi, and in vacuum ranges of 0-30" Hg.

No other pilot comes even close in a comparison of features with the USG Temperature or Pressure Pilot. The scope of applications is well beyond the range of ordinary pilots for flexibility and accuracy, and compares favorably with much more expensive controllers.

Write for descriptive catalog, or get it from your distributor . . . his name is in the "Yellow Pages" of your phone book.

UNITED STATES GAUGE

Division of American Machine and Metals, Inc.
Sellersville, Pa.

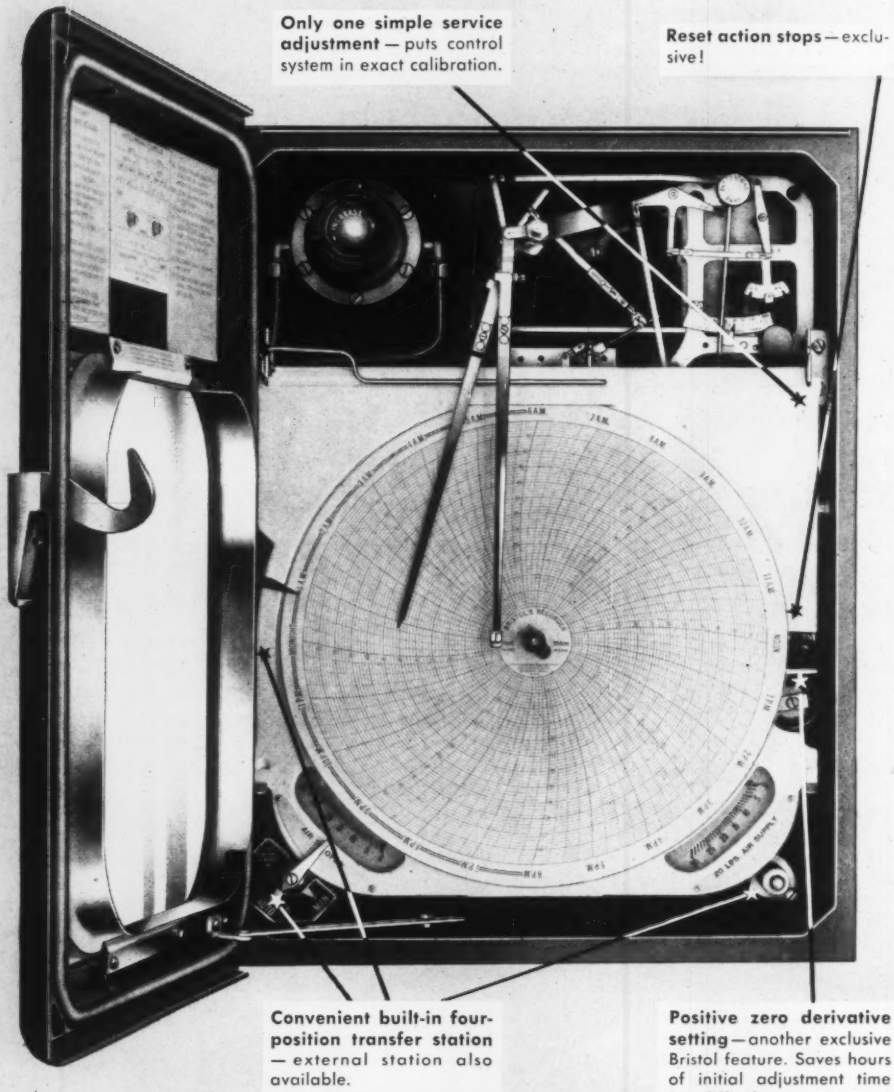
USG

Home of the SUPERGAUGE®

MORE THAN 50,000 TYPES OF GAUGES • SUPERGAUGES • SOLID FRONT GAUGES • RECEIVER GAUGES • TEST GAUGES • RECORDERS • CONTROLLERS • TRANSMITTERS • PSYCHROMETERS • AVIATION INSTRUMENTS

For more information circle **12** on inquiry card.

Are you sure you



Only one simple service adjustment — puts control system in exact calibration.

Reset action stops — exclusive!

Convenient built-in four-position transfer station — external station also available.

Positive zero derivative setting — another exclusive Bristol feature. Saves hours of initial adjustment time for difficult processes.

MADE IN MODELS FOR THESE CONTROL MODES:

1. **Fixed narrow band** (on-off).
2. **Proportional**—to 100% and to 30%.
3. **Reset with wide band**—rates 0.1 to 10 or 1 to 300 repeats per minute. Proportional band to 400%.
4. **Derivative** (rate)—Derivative time 0.2 to 20 min., plus zero derivative setting.
5. **Reset plus derivative**—proportional band, reset rate and derivative time as shown above.

WILL HANDLE THESE CONTROL PROBLEMS:

1. Cascaded control
2. Selective control
3. Ratio control
4. Time-program control
5. Pneumatic transmission.

For more information circle **13** on inquiry card.

are getting the best in pneumatic controllers?

Before you buy another controller check these advantages of the new Bristol Series 500 Free-Vane* Pneumatic Controller

FINEST MEASURING ELEMENTS

Bristol Series 500 Pneumatic Controllers are equipped with precision Bristol measuring elements—the widest selection of high-quality measuring elements available with any line of control instruments. You'll find models for control of: **temperature, pressure, vacuum, draft, absolute pressure, liquid level, flow, humidity, density, pH, and a large number of other variables measurable with electronic potentiometers and bridges.**

The sustained, predictable performance of Bristol measuring elements is one reason why you'll find more Bristol recording pressure gauges in use *than all other makes combined.* The new, completely linear Bristol Dual-Filled Vapor Pressure Measuring Element used in Series 500 Thermometer Controllers is the first really big advance in this field of measurement in 25 years. The Bristol Absolute Pressure Element, available in ranges as low as 0-6 mm of mercury absolute, also leads in its particular field. These are just a few of many examples of Bristol leadership in the development and improvement of measuring elements.

ADVANCED CONTROL SYSTEM FEATURES

Many features *found on no other pneumatic controller* assure better control with the Bristol Series 500: Reset action stops on reset models prevent loss of control due to prolonged deviation from set point; true zero derivative setting (on derivative models) can save hours of initial adjustment time; easy shift to wider proportional band (½ to 200% or 1 to 400% on wide band models) *without recalibration.*

BEST MAINTENANCE RECORD

One simple adjustment puts a Series 500 controller in exact calibration.

Basic simplicity, accurate design, closely held manufacturing tolerances make this single adjustment all that's necessary—even after complete disassembly and reassembly with replacement parts.

Bristol Series 500 Controllers on the job in new modern processing plant. Absolute pressure, steam flow, and liquid levels are variables controlled here.

This practically "built-in" calibration is typical of the foresight and engineering planning that make the Series 500 the easiest pneumatic control system on the market to service. Cut-and-try methods are eliminated. No special maintenance skills are required. All parts are completely interchangeable. The result: a truly superlative maintenance record in thousands of industrial plants.

NATION-WIDE SERVICE

Series 500 Controllers are backed up by the kind of service a quality product requires. The facilities of the main factory, four strategically-located branch factories, and factory-trained service engineers operating out of 44 principal cities across the United States and Canada are on call whenever and wherever needed to help you get the most out of your Bristol Pneumatic Controllers.

GET COMPLETE INFORMATION

. . . on the Bristol Series 500 Pneumatic Controller before you buy another instrument! Fully described in Bulletin A130. Write: The Bristol Company, 113 Bristol Road, Waterbury 20, Conn. 6.76

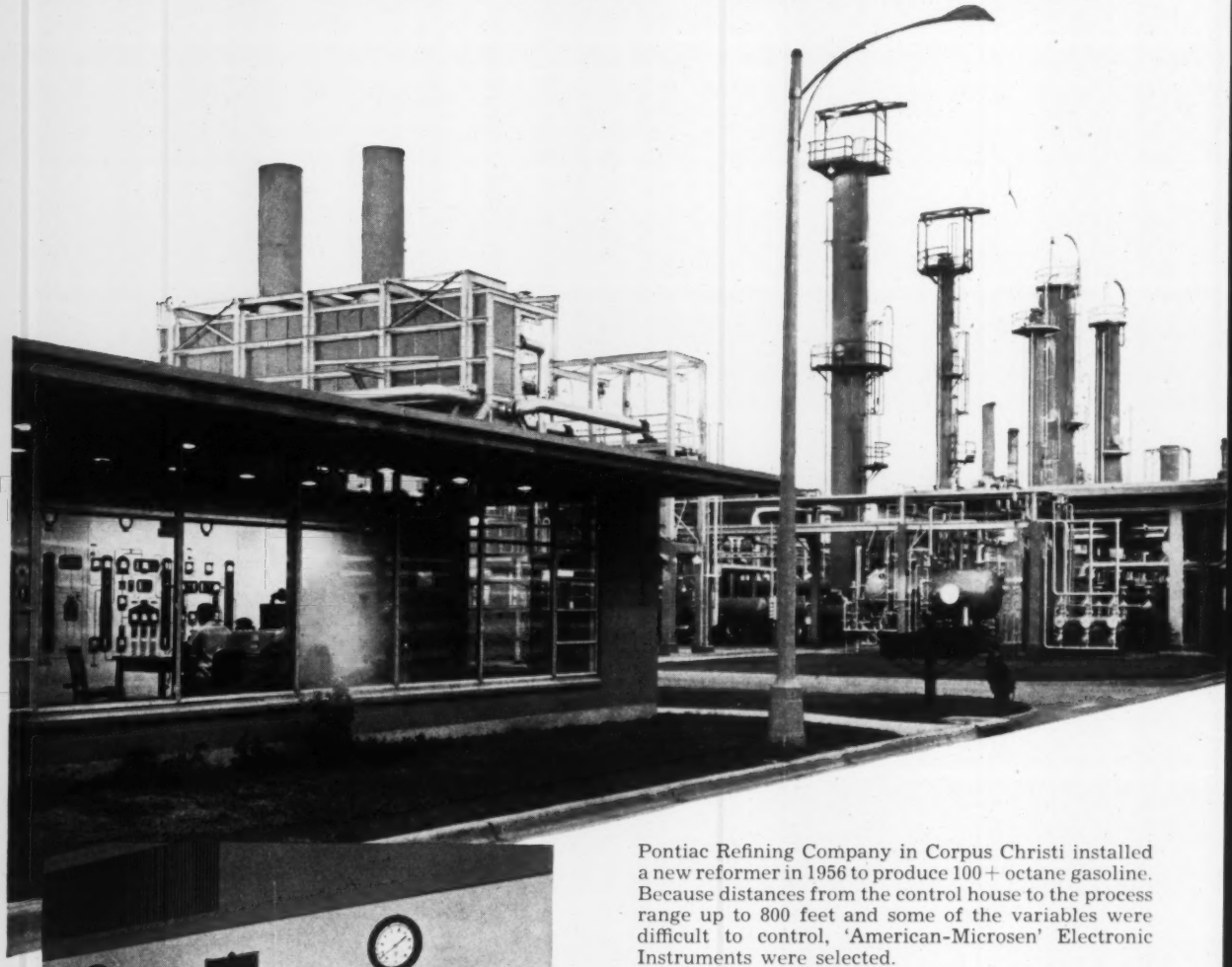
*T.M. Reg. U. S. Pat. Off.

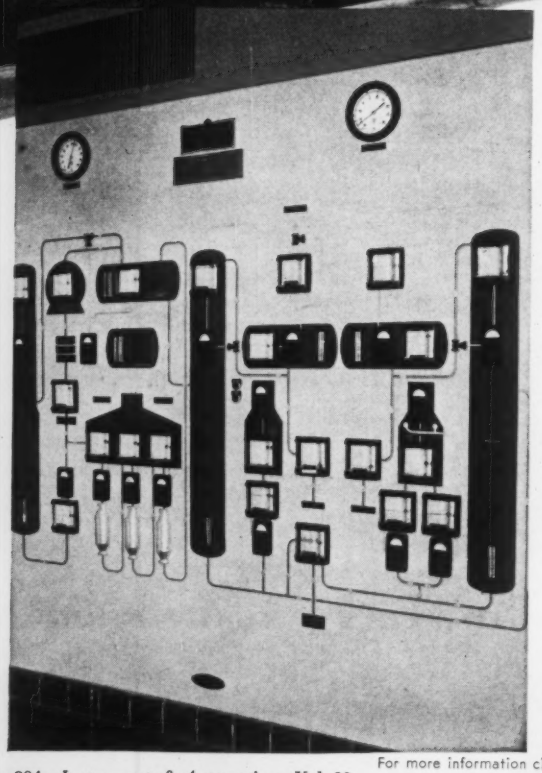
BRISTOL *TRAIL-BLAZERS IN PROCESS AUTOMATION*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **13** on inquiry card.

THIS REFINERY GOES ELECTRONIC...





Pontiac Refining Company in Corpus Christi installed a new reformer in 1956 to produce 100+ octane gasoline. Because distances from the control house to the process range up to 800 feet and some of the variables were difficult to control, 'American-Microsen' Electronic Instruments were selected.

The control house contains 'American-Microsen' Controllers for pressures, flows, levels, and temperatures of the process materials at vital stages of the platforming process. Despite the long distances and fast-acting variables, the instruments provide control well within the tolerances required to produce high-octane motor fuel.

Such results are possible because the 'American-Microsen' System is completely electronic, with dc transmission signal that is insensitive to distances as great as 30 miles. The high speed and sensitivity of the electronic design improve the control of all process variables.

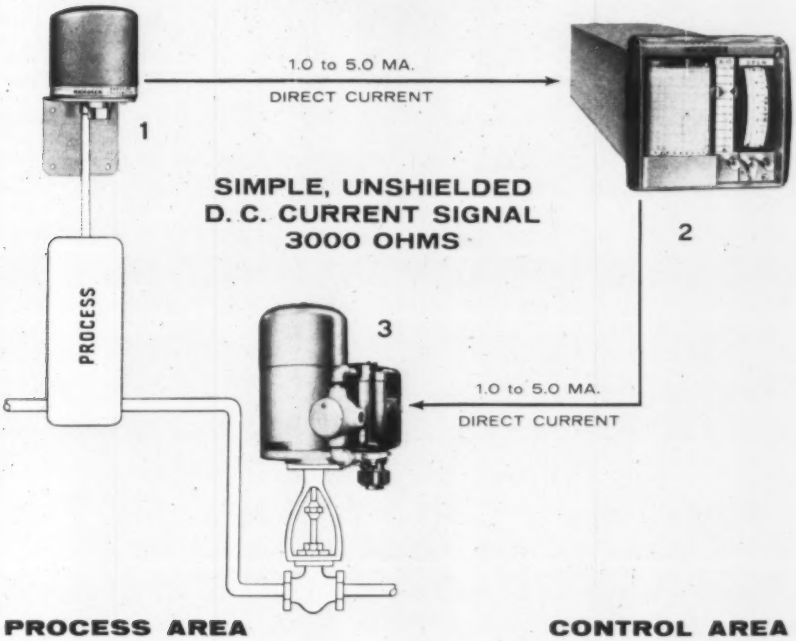
Now in operation over a year at Pontiac Refinery, the 'American-Microsen' System continues to give complete satisfaction — continues to help turn out high grade motor fuel. It is typical of many successful installations, and more and more companies are specifying the system for new plants as well as in modernizing existing processes.

Even though the electronics approach in process control is revolutionary, the 'American-Microsen' System of today incorporates the latest design techniques. Transistors are used for the ultimate in reliability and service life, and printed circuits and miniaturized components provide space-saving simplicity. The complete process control system now uses only three units.

For more information circle **14** on inquiry card.

the modern way to control process variables

'AMERICAN-MICROSEN' ELECTRONIC PROCESS CONTROL SYSTEM HELPS PRODUCE HIGH-OCTANE MOTOR FUEL



1. **TRANSMITTER.** 'American-Microsen' transmitters are used for measuring pressure, temperature, differential pressure, liquid level, flow, and other process variables. The "Microsen" balance creates a stable dc signal for long distance transmission. Transmitters have a minimum of bearing pivots or linkages—assuring sensitivity and repeatability of measurement.

2. **CONTROLLER.** A single unit combines all functions of measuring and recording or indicating the input signal; producing the control signal; and allowing manual-automatic process operation. Separate plug-in chassis provides the following functions: A. Records or indicates process variable. Strip or card chart recorder chassis available. B. Produces proportional, reset and rate control actions to regulate the variable. All control settings are calibrated. C. Permits switching to manual operation during start-up or emergency conditions, with true "bumpless" transfer from manual to automatic control.

3. **ELECTRO-HYDRAULIC CONTROL VALVE OPERATOR.** A power unit with position feedback that operates slip-stem control valves. No compressed air is needed. Mountable on standard yokes supplied with conventional slip-stem control valves with bodies of single or double-seated construction, with V-port, parabolic, needle and equal percentage plugs, including valves of 4" stroke, and force available up to 3,250 lbs.

Where required, the 'American-Microsen' Electro-Pneumatic Valve Positioner or the Electro-Pneumatic Transducer can be supplied.

In automating your processes for higher product quality and greater operating economy, you want the better control and simplified servicing provided by the 'American-Microsen' Electronic Process Control System. We invite you to meet with one of our sales engineers to determine the best equipment for your service. Write for literature.

MANNING, MAXWELL & MOORE, INC.

MAXWELL MANNING M&M & MOORE INC. TRADE MARK

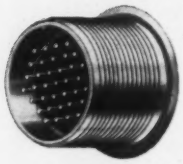
INDUSTRIAL CONTROLS DIVISION • STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN-MICROSEN' ELECTRONIC INSTRUMENTS FOR MEASUREMENT, TRANSMISSION AND CONTROL

For more information circle **14** on inquiry card.

INCREASED RELIABILITY

AMPHENOL HERMETIC SEALS



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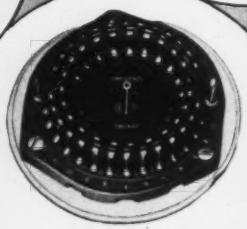
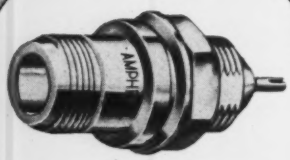
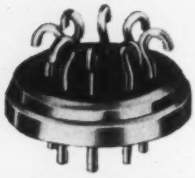


RACK & PANEL



RF



HEADERS

check your requirements:

A-N CONNECTORS—AMPHENOL's 172 series encompasses a complete line of hermetic seal receptacles that mate with standard AN plugs. Available in round flange, square flange and flangeless shells. Hermetically sealed receptacles for AMPHENOL's Miniature AN-types are also available.

R-F CONNECTORS—Almost every AMPHENOL RF series includes hermetically sealed receptacles: standard or special. Inquiries are invited.

RACK & PANEL CONNECTORS—A hermetically sealed circular Blue Ribbon with 50 contacts is standard; many custom engineered connectors have also been produced to special requirements.

HEADERS—A complete line of hermetic seal Headers is a recent addition to AMPHENOL's product groups. Available in a wide range of sizes and terminal layouts with any of four different contact styles.

In Hermetic Seals, as in every major component line, make contact with AMPHENOL!

AMPHENOL ELECTRONICS CORPORATION
chicago 50, illinois

AMPHENOL

1932 Anniversary AMPHENOL 1957

Events

May 27-29

Third National Telemetering Conference, Hotel Cortez, El Paso, Texas. For information write J. M. Sherman, Exhibits Committee chairman, Electro-Mechanical Resistors, 4933 Mesa Road, El Paso, Texas.

June 4-5

Rectifiers in Industry Conference of the American Institute of Electrical Engineers, Morrison Hotel, Chicago, Ill. For information write AIEE, 33 W. 39th St., N. Y. 18, N. Y.

June 4-6

Fundamentals of Punched Card Accounting Seminar, sponsored by the Institute for Management Progress, grand ballroom, Prince George Hotel, 14 E. 28 St., N. Y., N. Y. For information write Management Progress, Inc., 475 5th Ave., N. Y. 17, N. Y.

September 4-6

Magnetic Amplifiers Conference of the Institute of Radio Engineers-American and the Institute of Electrical Engineers, Penn Sheraton Hotel, Pittsburgh, Pa. For information write AIEE, 33 W. 39th St., N. Y. 18, N. Y.

June 9-14

ASME Semi-Annual Meeting, Sheraton Palace Hotel, San Francisco, Calif. For information write The American Society of Mechanical Engineers, 29 W. 39th St., N. Y. 18, N. Y.

June 9-14

Pennsylvania State University Automation Seminar, Pennsylvania State University, University Park, Penna. For information write Chester Linsky, Industrial Engineering Dept., Pennsylvania State University, University Park, Penna.

June 10-11

Second RETMA Symposium on Applied Reliability, Hotel Syracuse, Syracuse, N. Y. For information write J. A. Caffiaux, RETMA Engineering office, room 650, 11 W. 42 St., New York 36, N. Y.

← Circle **15** on inquiry card.

June 10-14

Symposium on Molecular Structure and Spectroscopy, Department of Physics and Astronomy, The Ohio State University. For information write H. H. Nielsen, Chairman, The Ohio State University, Columbus 10, Ohio.

June 13-15

Third National Symposium on Instrumental Methods of Analysis, University of Chicago, Chicago, Illinois. For information write M. D. Weiss, Program Chairman, Fischer & Porter Co., Hatboro, Pa.

June 17-19

National Convention and Exhibit on Military Electronics (Missiles and Electronics) of the Professional Group on Military Electronics, Institute of Radio Engineers, Sheraton Park Hotel, Washington, D. C. For information write L. D. Whitelock, 5614 Greentree Rd., Bethesda 14, Md.

June 17-22, June 24-26

Two Summer Courses in Automatic Control. For information write Prof. L. L. Rauch, Rm. 1521, East Engineering Bldg., Univ. of Mich., Ann Arbor, Mich.

June 19-21

Twelfth Annual Meeting of the Association for Computing Machinery, University of Houston, Houston, Texas. For information write J. F. Summers, The Texas Co., P. O. Box 2332, Houston 1, Texas.

June 27-July 1

British I. R. E. Convention of Electronics in Automation, University of Cambridge, London, England. For information write British Institution of Radio Engineers, 9 Bedford Square, London, W. C. 1, England.

August 26-30

Eighth Annual Infrared Spectroscopy Institute, Fisk University, Nashville 8, Tenn. For information write Nelson Fuson, Infrared Spectroscopy Institute, Fisk Univ., Nashville, Tenn.

September 9-13

12th Annual ISA Conference & Exhibit, Auditorium, Cleveland, Ohio. For information write William Kushnick, 313 Sixth Ave., Pittsburgh 22, Pa.

November 2-10

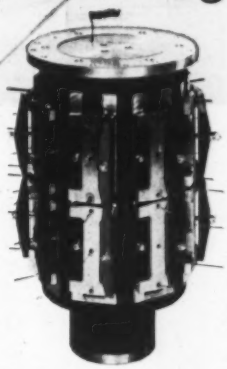
INTERKAMA (International Congress and Exhibition of Measuring Instrumentation and Automation), Dusseldorf, Germany. For information write Nordwestdeutsche Ausstellungs-Gesellschaft m. b. H., Ehrenhof 4, Dusseldorf, West Germany.

May 31-June 8, 1958

European Congress of Chemical Engineering and ACHEMA Congress, Frankfurt a.M., Germany. For information write DECHEMA, Dechema-Haus, Rheingau-Allee 25, Frankfurt a.m., West Germany.

Top companies in the computer field

use BRYANT magnetic storage DRUMS!



Bryant Magnetic Drums are used extensively by Remington Rand—Univac and other leading manufacturers of electronic computers, because of their accurate, dependable performance. These drums are used not only in digital computers, inventory control systems and tape-to-card converters, but also as delay lines, synchronizers and frequency generators.

FEATURES

- Designed to purchasers' requirements
- Guaranteed accuracy of drum runout .00010" T. I. R. or less
- Air bearings or super-precision ball bearings
- Belt drive or integral motor drive, speeds to 100,000 RPM or more
- Capacities to 5,000,000 or more binary digits
- Vertical or horizontal housing
- Head mounting surfaces to suit
- High density magnetic oxide coating

BRYANT GAGE and SPINDLE DIVISION
P. O. Box 620-I, Springfield, Vermont, U. S. A.
DIVISION OF BRYANT CHUCKING GRINDER CO.

For more information circle **16** on inquiry card.

GET THE BEST SOLUTION TO EVERY FLOW

. . . with Foxboro Instrumentation

Differential Pressure Cell Transmitters

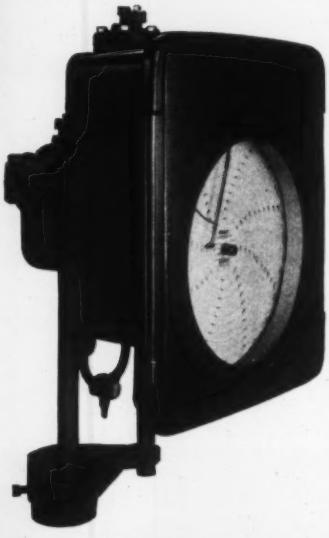
Complete line includes air-operated and electric-operated d/p Cell Transmitters covering ranges from 0-20" to 0-800" of water; working pressures up to 1500 psi.

Type 13A d/p Cell Transmitter

- Positive Overrange Protection—up to full 1500 lb. rating
- Fully Adjustable Ranges—0-20" to 0-250" water
- Automatic Internal Damping — fast, stable measurement
- Simplicity—easiest, lowest-cost installation, lowest maintenance

Mercury Type Meters

Complete line includes mercury types covering ranges from 2 to 400" of water; working pressures up to 5000 psi.

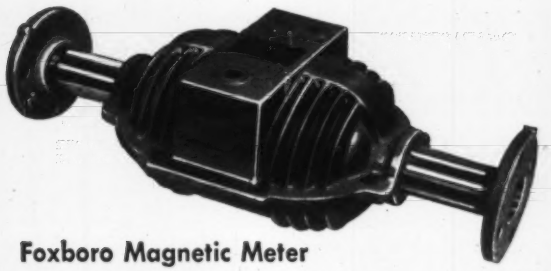


Type 28 Mercury Meter

- Permanent Full-Scale Meter Accuracy — exclusive segmental lever design provides linear transmission from float to pen
- Highest-Powered Pen Drive — large float with long travel
- Minimum Ambient Temperature Effects — float located in high pressure chamber

For more information circle **17** on inquiry card.

PROBLEM



Foxboro Magnetic Meter

- Measures Fluid Velocity Directly
- Adds No Pressure Drop
- Uniform Flow Scale
- Overall Accuracy Better than 1% of Range Over Entire Scale
- Full Accuracy Sustained Even on Liquids Other Meters Can't Handle — even sand and water slurries

THERE ARE two logical reasons why Foxboro Instrumentation assures you *optimum* results in measurement or control of process fluid streams. First; Foxboro offers the widest variety of measuring and controlling devices . . . the *right* equipment for every application. For example, only Foxboro offers all these basic meter types: differential pressure cell flow transmitters, magnetic meters, mercury meters, and weir meters. Second; Foxboro provides 45 years of engineering experience in every phase of fluid mechanics. From the simplest general utility-type instrument to complex automatic ratio control systems, you get highest accuracy, efficiency, and economy. Whenever you have a flow problem involving liquids, vapors, gases, or slurries — in pipes, ducts, or channels, you can solve it best by specifying Foxboro. Only a few instruments are described on these pages. For full details; or for specific information on *your* problem, contact your nearby Foxboro Field Engineer, or write The Foxboro Company, 465 Neponset Ave., Foxboro, Mass.

FOXBORO

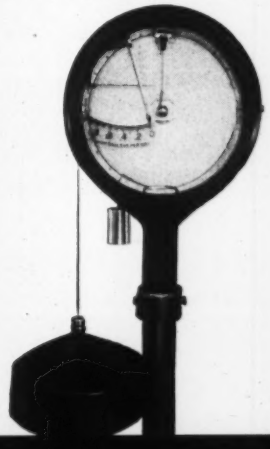
REG. U. S. PAT. OFF.

FIRST IN FLOW

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

Float-and-Cable Type Meters

- Rigid Construction — weather-tight case; all working parts of corrosion-resistant materials
- Powerful Accurate Operation — large, high-stability float; stainless steel cable — non-stretching, non-twisting
- Direct Reading Chart and Scale
- Direct Reading Integral Counter



Other Foxboro Flow Instrumentation

Electric or Pneumatic Type Rotameters

Electric, Pneumatic, and Mechanical Integrators

Planimeters

All Primary Elements, Valves, and Accessories required for assembly of complete flow measurement and control systems

For more information circle **17** on inquiry card.

THE FAMILY OF Waterman POCKETSCOPES

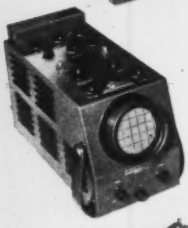
Portable—Dependable—Economical

Rugged, highly portable "pocket-size" oscilloscopes that can be carried to the job in one hand without sacrifice of the high precision that qualifies them for laboratory use. For field, production line, or laboratory, they save labor, space, money! POCKETSCOPES combine high electrical performance, reliability and low cost.

S-11-A INDUSTRIAL POCKETSCOPE

Features DC amplifier, repetitive sweeps and circuit ground isolation . . . for DC and low frequency work.

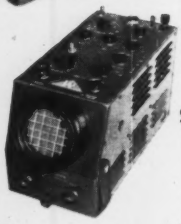
5" x 7" x 11" . . . 8¾ lbs. **$149.50**



S-14-A HI-GAIN POCKETSCOPE

Identical vertical and horizontal amplifiers, sensitivity to 10 mv; trigger or repetitive sweeps from ½ cps. to 50 KC; ± sync; calibrated voltages.

6" x 7" x 12" . . . 12¾ lbs. **$249.00**



S-14-B WIDE BAND POCKETSCOPE

Similar to S-14-A except lower sensitivity, greater bandwidth. Triggered or repetitive sweeps from ½ cps to 50 KC;

6" x 7" x 12" . . . 14 lbs. **$239.00**

S-14-C COMPUTER POCKETSCOPE

DC type signal amplifier bandpass more than meets need of most computer service... calibrated trigger sweeps; 5X trace expansion; excellent stability.

6" x 7" x 12" . . . 16 lbs. **$289.00**

S-15-A TWIN-TUBE POCKETSCOPE

A unique approach to dual trace oscilloscopy . . . two rectangular cathode ray tubes, common internal trigger or repetitive sweep generator . . . DC type signal amplifiers sensitivity to 10 mv.

6" x 7" x 12" . . . 16¼ lbs. **$399.00**

WATERMAN PRODUCTS CO., INC.

PHILADELPHIA 25, PA. CABLE ADDRESS: POKETSCOPE

MEMO... Write for details today!

MANUFACTURERS OF

PANELSCOPE*
PANELPACK*
PULSESCOPE*
RAKSCOPE*
RAYONIC* Cathode Ray Tubes
and Other Associated Equipment

*Registered Trademarks

WATERMAN PRODUCTS

For more information circle **18** on inquiry card.

Books

One Hundred Electronic Circuits, Vol. 1., by Milton H. Aronson and Charles F. Kezer. 1957. Instruments Publishing Co., 845 Ridge Ave., Pittsburgh 12, Pa. 168 pages, plus xii. $2.00. This book provides 100 circuits complete with detailed specifications and all values for the components. This is the unique feature of the book, and the idea which justifies the preparation of another electronics book. The circuits include 15 power supply circuits, 18 amplifier circuits, 15 oscillator and generator circuits, 20 pulse circuits, 17 test instrument circuits, 3 alarm circuits, 3 phototube circuits, and 9 miscellaneous (phase shifters, controllers, etc.) circuits, chosen to sample a broad area of modern electronic circuitry. Circuit designers will have their labors reduced because they will find herein circuits they are seeking or, from the operating specifications given, they will be able to modify the circuits to meet their needs. This book is not a book of principles—it is a book of circuits. But principles have not been ignored. The principles of series-tube-regulation, cascode circuitry, non-linear capacitors, starved-current amplification, electrometry, magnetic amplifiers, transistors, phase-shaft oscillators, tapered networks, modified-Harris oscillators, frequency standards, shaped transistor characteristics, blocking oscillators, binary counting, video mixing, rise- and fall-time compensation, cable capacitance cancellation, probe ringing, ionization gages, phototube sensitivity factors, negative inductance, phase shifting, bridge operation, keyed AGC, self-balancing phase inversion, cold-cathode memory tubes, and many others, are presented and discussed in terms of their actual operations.

R-F Transmission Lines, edited by Alexander Schure. [c 1956.] John F. Rider, New York 13, N.Y. 63 p. unbound. $1.25. 8½in. For students. Minimizes mathematics. Deals with fundamental concepts of transmission lines, with special attention to types of line in common use. Discusses operation, characteristics and applications.

Office Work and Automation by Howard S. Levin. [c 1956.] John Wiley & Sons, New York 16, N.Y. 203 p. $4.50. 9¼ in. Concerned with the more efficient handling of business information (in danger of being swamped in clerical routine), the book emphasizes guiding principles rather than specific techniques. It is addressed to the executive and the maker of decisions. It presupposes little direct knowledge of office machines or office methods, dealing with their importance rather than their actual operation.

Machine Literature Searching, by James W. Perry, Allen Kent, and Madeline M. Berry. [1956.] Interscience Publishers, New York 1, N.Y. 162 p. $4. 10¾ in. Includes 15 papers, 10 of which originally appeared in *American Documentation*, 1954-1955. Some attention to punched cards and to problems of terminology, codes and indexes, but is mainly an appraisal of future possibilities of searching literature by mechanical methods.

Electronic Engineering, by Samuel Seely. 1956. McGraw-Hill Book Co., New York, 36, N.Y. 525 p. $8. 9¼ in. This and a companion volume, "Radio Electronics", constitute a revision of the author's "Electron-Tube Circuits". Purpose is a detailed discussion of a wide variety of electronic circuits which are important in diverse fields, omitting applications in radio. Has chapters on electronic instruments, and transistors as circuit elements.

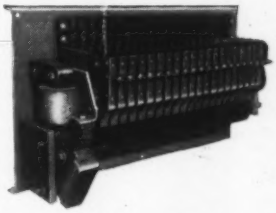
Electrical Interference, by A. P. Hale. [1956.] Philosophical Library, New York 16, N.Y. 122 p. $4.75. 7½ in. Discusses causes, effects, and suppression of interference with radio and television. British.

Reference Data for Radio Engineers, 4th edition. International Telephone & telegraph Corporation, 67 Broad Street, New York 4, N. Y.. 1121 pages of basic principles and tabular data, from units and conversions to digital computers and nuclear physics. $6.00

A Survey of Domestic Electronic Digital Computing Systems, by Martin H. Weik. 1955. U.S. Dept. of Commerce, Office of Technical Services. 272 p., unbound. $4.75. 11 in. Discusses the engineering characteristics, logical features, operating experiences, cost factors and personnel requirements of 84 systems. Includes analysis of the computer field, a discussion of trends, and a glossary.

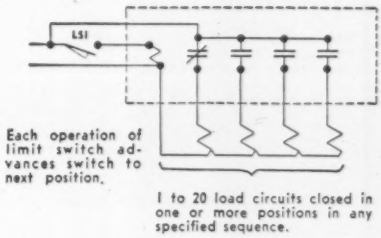
NEW EAGLE STEP SWITCH SIMPLIFIES CIRCUIT SEQUENCING

. . . for machine tools, presses, conveyors, processes

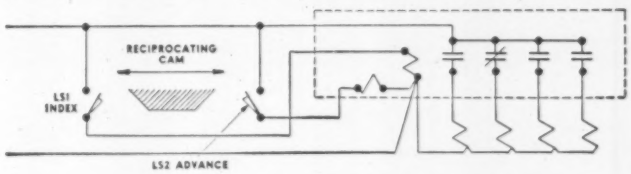


These 3 basic ideas are yours for simplified interlocking or sequencing of multiple load circuits. Any and all three will eliminate many other electrical components, and cut your initial cost.

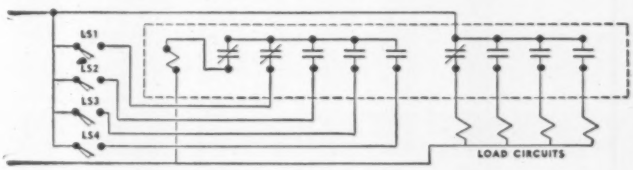
Operating load circuits in sequence: A limit switch on a machine or indexing device closes and opens upon each operation to advance the Eagle step switch. Or a timer may be used to operate each load circuit for a predetermined time.


LS1
Each operation of limit switch advances switch to next position.
1 to 20 load circuits closed in one or more positions in any specified sequence.

Interlock sequence: *Two limit switches* are operated alternately. This provides a safety feature. It insures that the movement of the machine has been completed before the Eagle step switch advances.



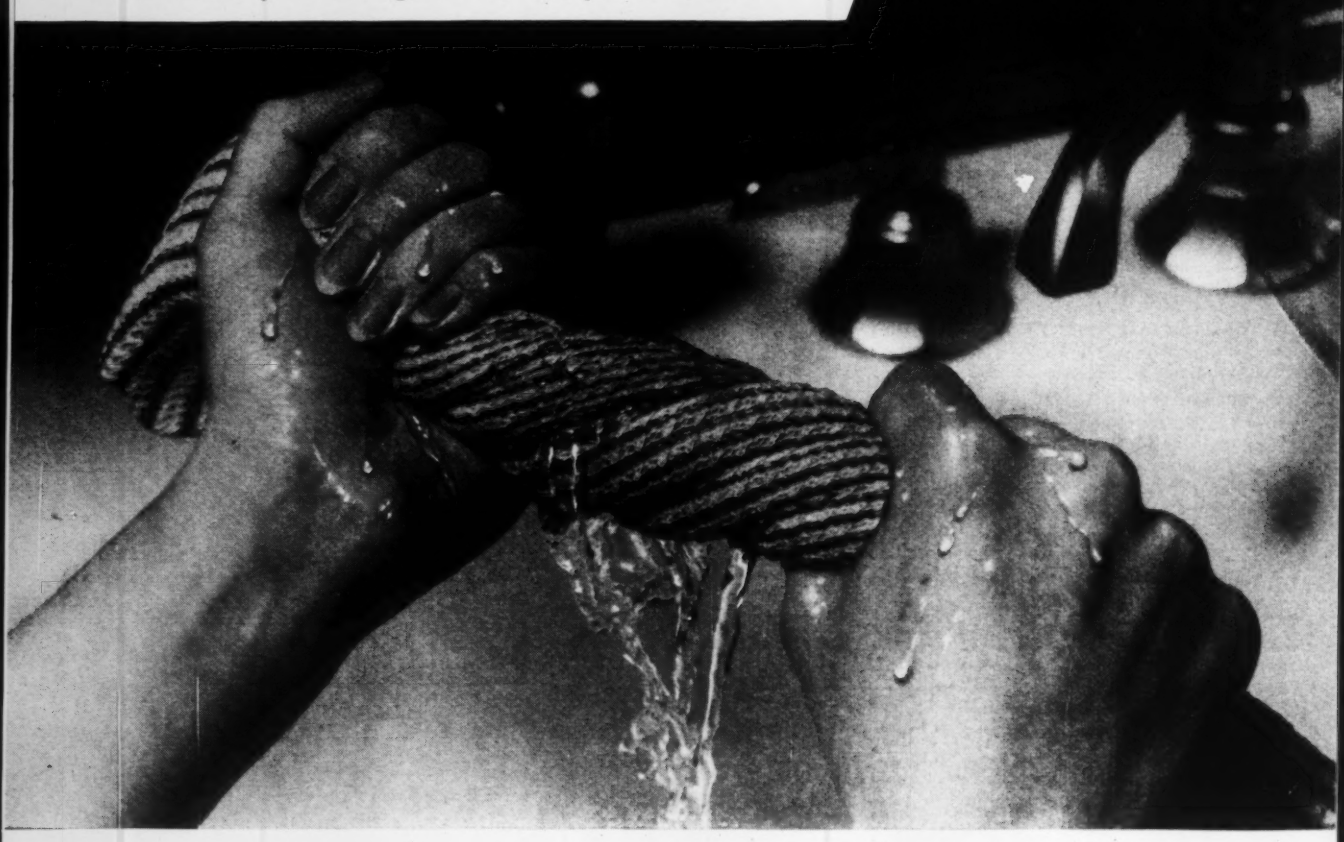
Interlock sequence with several limit switches: Each limit switch advances the Eagle step switch one position. Switches must operate in sequence or the step switch won't advance.



Send for new Eagle Bulletin 850. Simply write to Eagle Signal Corporation, Industrial Timers Division, Moline, Illinois, Dept. IA-557.

For more information circle **19** on inquiry card.

Sometimes you can guess at torque . . . BUT



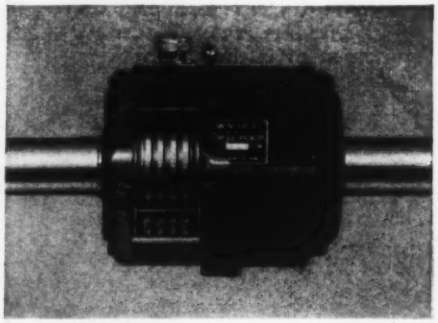
With SR-4® Torquemeters, you can measure and control all industrial torques to ±¼% accuracy

It isn't necessary to measure the exact amount of torque in order to wring out a dishcloth. But in industry, it's often vital that the exact amount of torque on a shaft be known.

You can use Baldwin SR-4 Torquemeters to measure a few inch-ounces or thousands of foot-pounds, and with consistent accuracy to within ±¼%. They convert torsion changes directly into changes in electrical energy, measure torque independently of speed, and take no power from the drive shaft. A wide variety of instruments can be used with SR-4 Torquemeters, ranging from millivoltmeter and battery to a computing instrument reading horsepower directly.

Baldwin SR-4 Torquemeters offer unlimited application opportunities. Present uses include torque measurement of viscosity, in engine dynamometers, for pump testing, in propeller drive shafts and helicopter rotor assemblies, and hundreds of other applications in design and production testing.

Whatever *your* torque measurement problem, a B-L-H representative is ready to serve you. For more complete information on SR-4 Torquemeters, write today for your free copy of Bulletin 4308.



The Type A SR-4 Torquemeter is a self-contained unit with housing and brush assembly suspended on a shaft by ball bearings. It employs SR-4 Bonded Wire Strain Gages in a Wheatstone bridge circuit. Baldwin torquemeters have been built for shafts from ¼ in. diameter to 18 in.; for zero rpm to 35,000 rpm; and from 10 in.-oz. capacity to 4,200,000 in.-lb.

BALDWIN · LIMA · HAMILTON

Electronics & Instrumentation Division

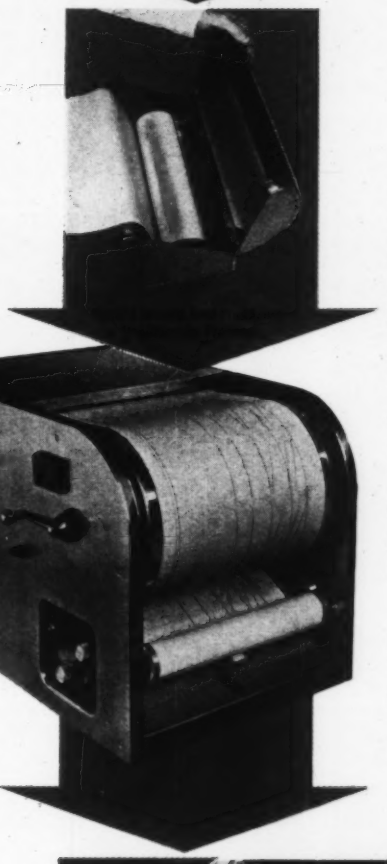
Waltham, Mass.

SR-4® strain gages • Transducers • Testing machines

For more information circle **20** on inquiry card.

NOW...

speed your recorded data with this portable darkroom



Get "on the spot" processing of paper records in minutes. CEC's Type 23-109 portable Oscillogram Processor is a completely self-contained, motorized unit designed for daylight operation without a darkroom. No external water supply is needed. Easy to operate by inexperienced personnel, the 23-109 gives you thermostatic control, greater record capacity (now 475 ft.), and wrinkle-proof records with the new Teflon-surfaced rollers. Please contact your nearby CEC field office, or write for Bulletin CEC 1537-X18.

CEC's OSCILLOGRAM PROCESSOR

Minutes later, developed record in engineer's hands.

Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena, California

NATIONWIDE COMPANY-OWNED SALES & SERVICE OFFICES

For more information circle **21** on inquiry card.

An experienced source for Process Stream Analyzers

MSA's quality control check-gas analyzers for dependable

We feel strongly about this operation in the production of our gas analyzers. It's called the Quality Control Check-Out, which is just another way of saying it's our final once-over to make sure the customer gets what he ordered.

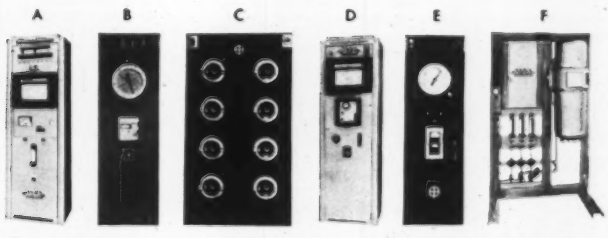
It sounds routine, but it isn't. Thirty years in the business of gas analysis instrumentation has given us a rigid check-list for measuring the accuracy and performance of every MSA instrument. We feel this preoccupation of ours with production quality is a good part of the reason why more and more people engaged in process stream control are favoring instruments with the MSA nameplate.

You'll find a line-up of our basic instruments at the right. These units are currently improving product quality, lowering processing costs and increasing safety throughout industry. We will be happy to have an Instrument Specialist call, or send you literature.

For more information circle **22** on inquiry card.

Highly trained personnel from MSA's Instrument Division tailor a wide variety of MSA gas analyzers to individual customer specifications.

out readies these on-stream analysis



A. M-S-A (LIRA) Infrared Analyzer
B. M-S-A Hydrogen Sulphide Recorder
C. M-S-A Combustible Gas Analyzer
D. M-S-A Gas Thermatron
E. M-S-A Oxygen Indicator
F. M-S-A Water Vapor Recorder

INSTRUMENT DIVISION

MSA

MINE SAFETY APPLIANCES COMPANY
Pittsburgh 8, Pennsylvania

For more information circle **22** on inquiry card.

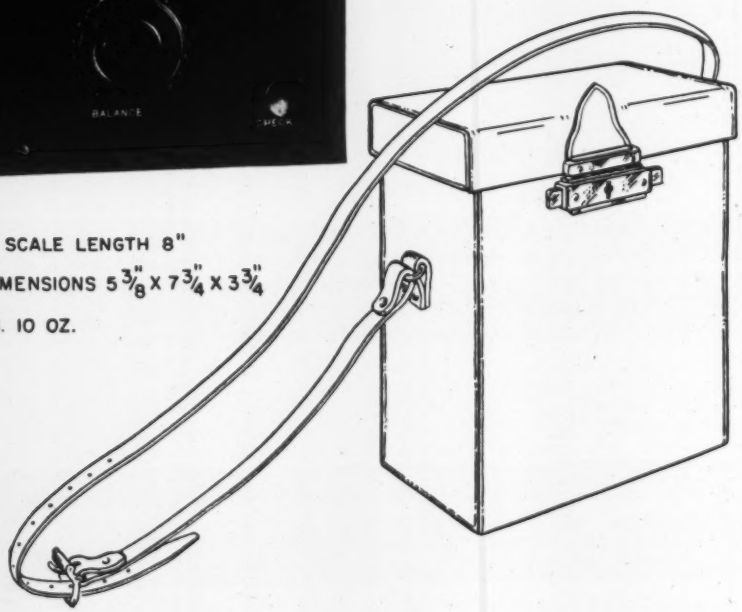
LEWIS MODEL 73 PO
PORTABLE
PYROMETER POTENTIOMETER

FOR MEASURING TEMPERATURES
electrically

- IN MOVING VEHICLES
- IN AIRCRAFT
- IN THE LABORATORY

30 STANDARD RANGES AVAILABLE TO FIT MOST REQUIREMENTS

TEMPERATURE SCALE LENGTH 8"
INSTRUMENT DIMENSIONS $5\frac{3}{8}$" X $7\frac{3}{4}$" X $3\frac{3}{4}$"
WEIGHT 4 LBS. 10 OZ.



THE LEWIS ENGINEERING CO.

NAUGATUCK, CONNECTICUT

Manufacturers of Complete Temperature Measuring Systems for Aircraft

For more information circle **23** on inquiry card.

INSTRUMENTS and AUTOMATION Trends

Automatic operation of broadcast stations, first radio, then TV, is new field with great promise. Canada has already approved automatic station operation; FCC approval is expected for USA. Automatic transmitters with outputs of 1, 5, 10 and 50 kw are available, with automatic programming, automatic record selection and play, automatic announcements, etc.

Receiving tube sales in Feb. 1957 are reported as 44.4 million units (compared with 37.7 million units in Feb. 1956); transistor sales in Feb. 1957 are reported as 1.7 million units (compared with 0.6 million in Feb. 1956).

Greater reliance on nuclear-warheaded guided-missile warfare is leading to basic changes in defense policies; has already occurred in Great Britain; may spread to other nations by force of circumstance. Immediate result: cutbacks in conventional weapons—tanks, manned aircraft, naval vessels—and greater emphasis on missiles, electronics, nucleonics and instrumentation. Long-range result (in absence of new foreign policies): guaranteed use of nuclear warfare and end of civilization and human life on third planet in solar system.

Transistor market in 1956 was $34 million, and is forecast as $150 million in 1961, and $225 million by 1965, says Texas Instruments.

Be careful of all productivity figures for entire nations—figures can vary widely between industries, and on type of calculation. BLS alone has 4 different estimates on productivity, which vary from 3.1 to 3.6% annual increase in productivity in USA between 1947 and 1953.

Temperature levels obtainable from nuclear reactions can be from millions of degrees (as in bombs) to room temperature (as in Zero Power Reactors). Reactors for power generation are designed to operate from 500-1000 degrees F. for metallurgical reasons.

Intruder alarm market is estimated at $6 million in U.S. by Walter Kidde & Co.; is expected to reach $15 million in 5 years. Types include infrared, capacitance, ultrasonic, sound, photoelectric, and contact.

Resistor sales in 1956 are reported as $155 million, compared with $125 million in 1955. Approximate breakdown by resistor types: fixed composition—32%; variable—27%; wire-wound—30%; others—11%.

ELIMINATE THE [illegible] ERROR FROM YOUR THERMOCOUPLE MEASUREMENTS

MODEL RJ 12
(U.S. PATENT PENDING)

...UPLE REFERENCE JUNCTION

Now accepted in most of the nation's missile and aircraft flight test programs, the **ARNOUX "HOT" REFERENCE JUNCTION** is fast superseding ice baths and bridge compensating networks in airborne applications.

Comparative data prove the Arnoux RJ contributes up to 10°F less error, under severe environmental conditions, than other commonly used techniques. Moreover, it requires no servicing prior to flight, and operates indefinitely without attention of any kind.

Regulation of the nominal 250°F junction temperature is within ± ½°F, at constant ambient. Environmental ambient variations of − 65 to +200°F cause less than ± 2°F total drift of the nominal. Maximum spread between junctions is 1°F. MIL E-5272A vibration and acceleration cause negligible error.

Operation of the RJ is simple. Thermocouple leads are soldered to the SPECIAL RED AN INPUT CONNECTOR containing pins of thermocouple alloy. Copper output and power leads are soldered to the STANDARD AN OUTPUT CONNECTOR. Special conversion tables for 250°F junction correction are furnished.

Airborne models available in 2, 4, 8 and 12 channels for use with any thermocouples specified. Size: 3" x 3½" x 4¾". Weight: 1¾ lbs. Power: 28V DC, 15 Watts.

Rack mount models also available for ground applications, with capacities of 24, 48 and 72 channels. Power: 115 V AC, 60 cps.

Get the facts . . . write for APPLICATION NOTE RJ1001, a frank analysis and comparison of the three common reference junction techniques.
For more about the Arnoux RJ, ask for Bulletin 400.

AR[illegible]UX

ARNOUX CORPORATION

Designers and Manufacturers of Precision Instrumentation

11924 WEST WASHINGTON BLVD. • LOS ANGELES 66, CALIFORNIA

For more information circle **24** on inquiry card.

NOW! LOW COST
MODULATING CONTROL
FOR TEMPERATURES UP TO 600° F

ANOTHER NEW IDEA FROM FULTON SYLPHON

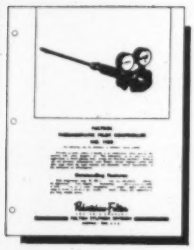
New FULTROL Thermostatic Pilot Controller No. 1100-C & D

Here is another example of how Fulton Sylphon gives you the best temperature control for your process at the lowest possible cost. This time it's an all-new FULTROL Thermostatic Pilot Controller—a simple, compact unit that now enables you to control temperatures up to 600° F. with *proportional* accuracy, but at *on-off* cost.

All that FULTROL needs is an air or other supply at a constant pressure anywhere between 18 and 40 psi. From then on, FULTROL strait-jackets temperature by modulating the output pressure to a final control valve, damper, or other device. FULTROL does all this by means of a simple, stainless steel thermal element. There are absolutely no troublesome pivots or levers.

What's more, you get all these extra features in the bargain:

- Instant knob adjustment of control setting over any 200° range specified between —50° F. and 600° F.
- Easily adjustable proportional band from 5° to 25° F.
- Protection against over-run temperatures (100° above range limit)
- Resistance to pressures up to 300 psi.



SEND TODAY FOR CATALOG SHEET NO. 10-28JL

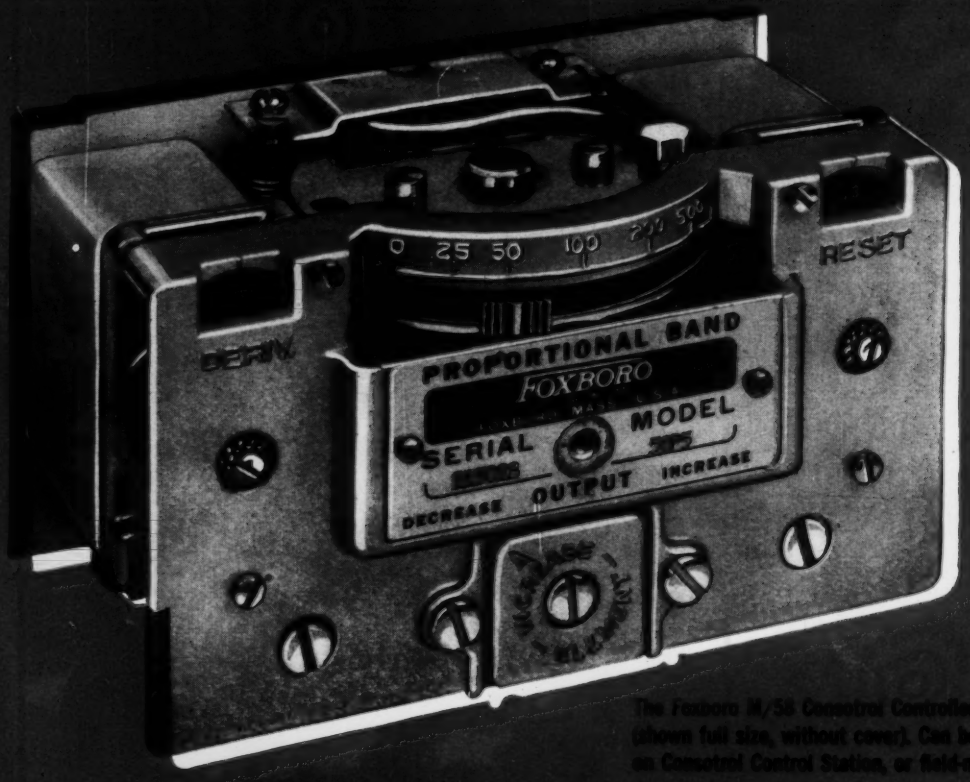
Mr. Controls

Robertshaw-Fulton CONTROLS COMPANY

FULTON SYLPHON DIVISION • Knoxville 1, Tenn.

TEMPERATURE REGULATOR HEADQUARTERS U.S.A.

For more information circle **25** on inquiry card.



The Foxboro M/58 Consotrol Controller (shown full size, without cover). Can be panel-mounted on Consotrol Control Station, or field-mounted.

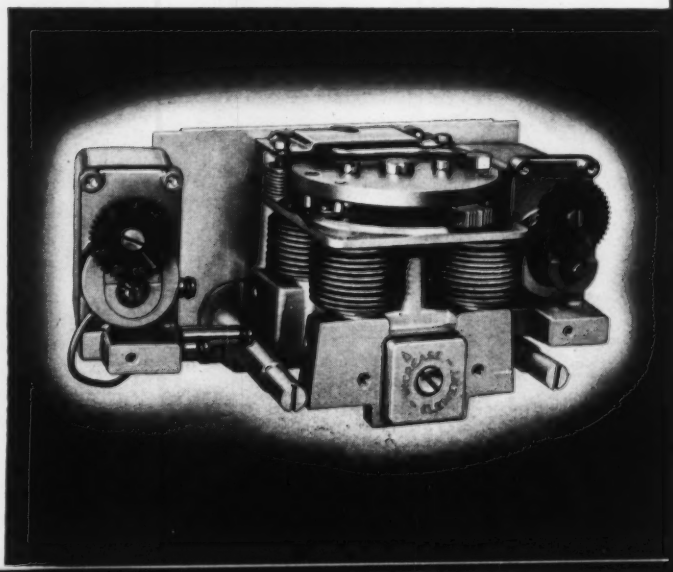
THE FOXBORO M/58 CONSOTROL

The M/58 Controller's Revolutionary Floating Disc System

Here's the exclusive Foxboro design development that gives M/58 Control its unique versatility, precision, and stability. The floating disc and matched bellows assure uniformly high controller sensitivity and pin-point control action, even at widest settings of the proportional band. Lever-set proportional band adjustment is calibrated to 500%.

Component Construction Gives Unrivaled Versatility

Not only is the complete controller easily detachable as a unit, but also, each component is a "plug-in" unit. For example, reset plugs in at right as shown; derivative, similarly, at left. All 4 control actions, with 2 reset ranges, are available and easily adjustable to widest variations in operating conditions. Proportional action from 1 to 500% quickly set by lever.



For more information circle **26** on inquiry card.

Outperforms all other controllers!

...the controller with the FLOATING DISC

If you think this claim is exaggerated, just put a Foxboro M/58 Consotrol* Controller on your process. The tougher the job, the more it will outperform other controllers! Or ask any present user . . . many of the largest, most progressive petroleum and chemical processors are using hundreds of these instruments. They will unhesitatingly confirm that this exclusive Foxboro development has put their processes "on stream", automatically and smoothly from the control room, without false starts or confusion.

The M/58 Controller can do the same for your process. The flexibility of its control functions makes it readily adaptable to *all* processing techniques. All four actions are available, with two ranges of reset . . . all are easily adjustable to the most widely varying operating conditions. For example, reset and derivative functions plug in . . . proportional action from 1 to 500% can be quickly set by a lever. And calibration is a simple zero adjustment!

Get full details on this simple, truly "universal" Controller. Write for Bulletin 13-19 and ask your Foxboro Sales Engineer for a demonstration. **The Foxboro Company, 465 Norfolk Street, Foxboro, Mass., U.S.A.**

*Reg. U. S. Pat. Off.

FOXBORO *Reg. U.S. Pat. Off.* **CONSOTROL INSTRUMENTS**

For more information circle 26 on inquiry card.

ECONOMICAL FROM EVERY ANGLE

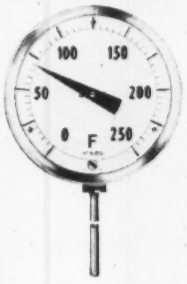
'AMERICAN' "Every Angle" THERMOMETERS

No longer is it necessary to fuss and figure what angles of stem connection are required in thermometers for each location. These American "Every Angle" Dial Thermometers can be set at any angle within 180° on *two* axes – set at the best angle for easiest reading.

Regardless of what piping arrangements are engineered into your processes – no matter how many times they are revised – the list of American "Every Angle" Thermometers in your original specifications need not be changed. Equally important, your thermometer inventory in all required temperature ranges and stem lengths will be far smaller. That's real economy – from every angle.

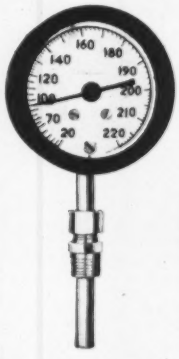
Bi-metal . . . mercury . . . vapor pressure – all three types of actuation are available in American "Every Angle" Dial Thermometers. They are precision instruments that assure accuracy within 1% of scale range. Their high accuracy is sustained throughout service life, whether installed indoors or outdoors.

Make full use of these highly sensitive thermometers at all important check points in your plant. You will maintain product quality far better than ever before. Your field operators will be able to take readings more easily, more accurately, more frequently – will save time-stealing trips to the control house. Convince yourself of the all-around economy of American "Every Angle" Dial Thermometers. Write for complete information.



BI-METAL ACTUATED, TYPE 6060AH. 5" Anti-Parallax Maxivision Dial. **Temperature Ranges:** –80/120 F. to +200/1000° F. **Stem Lengths:** 4" to 24". Climate-proof stainless steel case.

MERCURY ACTUATED, TYPE 6042RM. 4½" Anti-Parallax Maxivision Dial. **Temperature Ranges:** –20/120° F. to 200/1000° F. **Stem Lengths:** 4" to 24". Climate-proof glass and stainless steel case.



VAPOR PRESSURE ACTUATED, TYPE 6040TW. 3½" Dial. **Temperature Ranges:** –20/120° F. to 260/450° F. **Stem Lengths:** 3" to 24". Models for indoor or outdoor service.

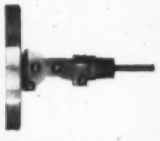
Separable sockets can be supplied in all materials and sizes normally required.

SET-ABILITY THAT MEANS FLEXIBILITY IN APPLICATION

SET IT for use as a side angle, 90°, oblique or top connection thermometer.

SET IT for use as a straight-form thermometer.

SET IT for use as an oblique-form thermometer.



SET IT for use as a standard 90° back-connected thermometer.

CALL ON YOUR INDUSTRIAL SUPPLY DISTRIBUTOR for experienced counsel in dial thermometer selection. You can depend on him for prompt delivery from local stocks.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

AMERICAN INDUSTRIAL INSTRUMENTS

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONN.

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Okla.* AIRCRAFT CONTROL PRODUCTS, *Danbury, Conn., and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

For more information circle **27** on inquiry card.

TECHNIQUES and DEVELOPMENTS in oscillographic recording

FROM SANBORN

RECORDING METHOD USED IN SANBORN DIRECT WRITERS, AND A REVIEW OF THEORETICAL AND ACTUAL ERROR FACTORS

Figure 1 shows the basic scheme by which Sanborn oscillographic recording galvanometers produce graphic records of electrical signal values. If the rapid deflection action of the heated ribbon tip stylus is visualized when current flows in the coil, it can be seen that a straight line at right angles to the chart length is recorded on the chart, at the point where the chart is drawn over a knife edge. The trace, therefore, is a true rectangular co-ordinate graph.

Since this is essentially a process of expressing coil (or stylus) deflection *angles* in terms of *distances* on a chart, the trigonometry of the situation (Fig. 2) must be examined to ascertain the accuracy of the method. Initially, and when θ is small, the tangent and the angle are almost equal numerically. The expression $D = R \tan \theta$ can, therefore, be rewritten $D = R\theta$ (approx.). To the extent this latter expression is true, deflection distances (rather than deflection angles) are an accurate measure of signal values. But to determine the extent of error resulting from using this approximation, the following data have been calculated*, using a chart width of 25 mm either side of zero ("D" in Fig. 2) and effective stylus length of 100 mm ("R" in Fig. 2) in the series expansion for the tangent function. Error as a function of deflection then becomes:

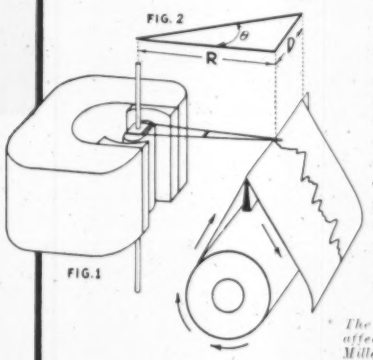


FIG.1

D mms	Radians	Theoretical Error ϵ	Corrected Error δ	Corrected Error in mms
10	.10	.0033	0	0
15	.15	.0075	.004	.06
20	.20	.0133	.010	.20
25	.25	.0209	.018	.45

When the recording system is calibrated, that calibration is often made on the basis of a one centimeter deflection from the chart center, or by means of a two centimeter deflection starting one centimeter below chart center and finishing one centimeter above chart center. In either case the deflection at one centimeter from chart center is accepted as the standard; and, therefore, is without error. The foregoing table can therefore be corrected by subtracting .0033 from each of the error terms to show the error, δ, to be expected in actual use. The final column in the table shows this error in mms.

Since the active length of the stylus increases as θ increases, deflection D increases more rapidly than θ. All positive error terms in the series expansion bear this out, but the error terms would occur as predicted only if the galvanometer produced deflections exactly proportional to coil currents (that is, ideal spring properties in the torsion rods and uniformity of magnetic field). Pole tips in Sanborn galvanometers are proportioned so that in maximum deflections, galvanometer sensitivity *decreases* slightly, the compensation resulting in *actual* linearity better than that predicted in the table.

* *The mathematics involved here, as well as a discussion of fixed length stylii, design parameters affecting over-all galvanometer performance, etc., are contained in an article by Dr. Arthur Miller "Sanborn Recording Galvanometers", published in the May 1956 Sanborn RIGHT ANGLE. Copies are available on request.*

RECOGNIZE A "150" RECORD BY THESE *THREE* FEATURES...

1% Linearity

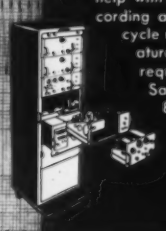
. . . resulting from use of current feedback Driver Amplifier in each channel, high torque galvanometers of new shorted coil frame design. Coil current of 10 ma develops 200,000 dyne cm torque, sensitivity is 10 ma/cm deflection.

Rectangular Coordinates

. . . save analysis time, simplify interpretation and correlation of multi-channel records. No waveform curvature, negative time lines, etc.

Permanent Inkless Traces

. . . made by hot nichrome ribbon tip of stylus on heat-sensitive Sanborn Permapaper. Clear, smudge-proof traces that clearly reveal minute signal changes.



Call on Sanborn engineers for help with your oscillographic recording application in the 0-100 cycle range. Descriptive literature is also available on request, providing data on Sanborn 1-, 2-, 4-, 6- and 8-channel Systems, choice of 12 interchangeable plug-in Preamplifiers, Separate and Supplementary Instruments.

SANBORN COMPANY
Industrial Division
175 Wyman Street, Waltham 54, Mass.

For more information circle **28** on inquiry card.

INSTRUMENTS and AUTOMATION News

Principles & Applications ....824 to 834
Stock Report 834
New Plants & Mergers 839
People in the News 843

"Interkama" and "Achema" Exhibitions in Germany

PITTSBURGH, PA—"INTERKAMA" (a contraction of German words for International Congress and Exhibition of Measuring Instrumentation and Automation) will be the first event of its kind in Germany. To be held in Dusseldorf, November 2-10, 1957, it was felt in manufacturing circles in Germany to be " . . .a necessity for Germany . . . to arrange for a similar display as the others regularly held in the USA." The idea of holding clinics for 20 or 25 persons by the exhibitors, as first introduced here on a large scale by the International Automation Expositions a few years ago, has also kindled enthusiasm in the circles organizing this event.

The twelfth Exhibition and Congress of Chemical Engineering ("ACHEMA Congress 1958") is scheduled in Frankfurt a/M for May 31 to June 8, 1958. Other organizations will hold conferences at the same time. The space requirements for the display of instruments and automation devices is amazing: 90 exhibitors of industrial instruments will use 86,000 sq ft, and 80 companies manufacturing scientific and laboratory instruments have reserved 80,000 sq ft. For details see page 807.

"Radio Pill"

NEW YORK, N. Y.—The Rockefeller Institute, The Radio Corporation of America and The New York Veterans Administration jointly announce a new broadcasting capsule which can be swallowed like a medicinal pill,

designed for studying the physiology of gastrointestinal pressure. The "pill" consists of a transistor oscillator, a ferrite-cup inductance core and a minute battery. One end is sealed by a flexible rubber membrane which transmits body pressure variations through a coil to a diaphragm. The signal generated, at approximately one megacycle, varies in frequency with the changing pressure on the diaphragm. As the "pill" swallowed by the patient passes through the gastrointestinal track, it emits signals and its course can be traced. Drs. Vladimir K. Zworykin and John T. Farrar designed the "radio pill."

Pittsburgh's Iron & Steel Instrumentation Conference Sets Attendance Record

PITTSBURGH, PA.—The Seventh Conference on Instrumentation for the Iron and Steel Industry, held annually by the Pittsburgh Section ISA in March, registered a record 378 participants who heard 12 excellent papers in the field. The number constitutes a gain of nearly 54% over last year's comparable figure, which had shown a steady increase over the years. The event which drew visitors from the steel centers throughout the nation and Canada has become the leading iron-and-steel instrument event.

Oldenburger Selected as Control Committee Head

LAFAYETTE, IND.—Professor Rufus Oldenburger of Purdue University has been selected chairman of the five-man "North American Control Committee" formed by the ASME, the AIEE, the IRE, the ISA and the AICHE. The Committee was formed to represent the American engineering societies in the organization of the International Control Federation. Participation in, and decision to form, this federation was pledged at Heidelberg, Germany in 1956 by control specialists of 18 nations where there is automatic control activity. Professor Oldenburger was elected to the International Provisional Control Committee to make arrangements for the formation of the Federation, and to promote the idea.

"Humanizing" The Electronic Brain

SAN DIEGO, CALIF.—Engineers of Stromberg-Carlson are planning to build a machine which will enable a human being to tell a computer what to do more often and more easily. Developed by the Servo Mechanisms Lab at M.I.T., it is called "Gestalt System." Its purpose is "to facilitate the transmission of general ideas, as in a conversation, between a human and a computer, so that the maximum use of their respective capabilities can be made." Stromberg-Carlson has contracted to produce the first application of the system for the Air Force Armament Center, Eglin, Fla.

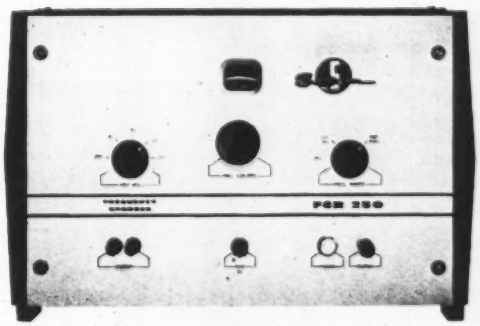
NOW-PORTABLE
400 cycle power

This new frequency changer makes it possible to provide well regulated 400 cycle power conveniently and quickly. This unit, Model FCR 250, is extremely useful in a wide variety of applications including testing, production, airborne frequency control, computers, missile guidance system testing, and in practically any application where the use of 400 cycle power is advantageous.

Model FCR 250 is only one of a complete line of frequency changers available from Sorensen . . . the authority on controlled power for research and industry. Write for complete information.

ELECTRICAL CHARACTERISTICS

Input	105-125 VAC, 1 phase, 50-65 cycles
Output voltage	115 VAC, adjustable 105-125V
Output Frequency	320-1000 cps in two ranges
Voltage regulation	±1%
Frequency regulation	±1% (±0.01% with auxiliary frequency standard fixed at 400 cycles)
Load range	0-250 VA



MODEL FCR 250

SORENSEN & COMPANY, INC. Sorensen **STAMFORD • CONN.**

In Europe, contact Sorensen-Ardag, Eichstrasse 22, Zurich, Switzerland, for all products including 50 cycle, 220 volt equipment.

For more information circle **29** on inquiry card.

Kipfel
GOLDEN GENIE
Self-Operating TEMPERATURE REGULATOR

- Overheat Protection
- Indestructible Yoke
- Direct or Reverse Acting
- Single, Double or Three Way Bodies
- Wide Temperature Range

NEW
Process Product Profit
FLOW INSURANCE!

Install it—*forget it!* Yes, this new completely self-operating temperature regulator is equipped with a rugged 2-ply (double wall) seamless bellows to *insure* long, dependable valve actuation and prevent overheating and spoilage of products . . . damage to process equipment . . . expensive down-time. In an emergency, an exclusive over-ride control (optional) permits manual operation.

Built for dependable service, rugged cup type seamless 2-ply Bellows, develops more power.

New Golden Genie offers many years' ahead features for increased efficiency and economy. Write us—we'll send the proof!

Kipfel
VALVES, INC., Div. of Hamilton-Thomas Corp.
Dept. D-5, Hamilton, Ohio
Export Dept., 1010 Schaff Bldg., Philadelphia

For more information circle 30 on inquiry card.

Electronic Sorting Speeds Mail

NEW YORK, N. Y.—An electronic system for sorting mail automatically was disclosed at the recent IRE Convention. Under development by the Canadian Post Office Department in Ottawa, the names of towns, villages, and streets are converted into a special code suitable for electronic handling. This code is marked on the envelope by a special key board and the sorting is performed automatically by high-speed electronic sorting equipment.

Styrene from Gasoline Avoids Costly Synthesis

BIG SPRING, TEX.—The only plant producing styrene by direct recovery of ethylbenzene from gasoline has been built, and is running under instrument control. It is producing plastic-grade styrene above specifications, and commitments for 20 million pounds per year are

expected to be reached. Cosden Petroleum Corp. starts with mixed xylene, and critical separation of ethylbenzene is performed by Badger Manufacturing Company's ultrafractionation columns utilizing new processing techniques which include dehydrogenation, recovery and purification. Picture shows ultra-modern control room with miniature recorders on graphic panel.

Executives Play "Monopoly" with IBM 650

NEW YORK, N. Y.—On Thursday May 2, twenty top company presidents gathered at the American Management Association's Sheraton-Astor headquarters to play a unique and important game—a business game somewhat like the war games in which field commanders pit their armies against each other in mock battle.

In this case, each executive starts out with an "industry," complete with plants, products, research labs, and sales force. He can make 20 decision types—from reducing price to selling plants to increasing research. Each decision taken then affects the market, leading to a new situation facing the executive.

An IBM 650 electronic computer calculates the results of each company's decisions, compressing years of reaction into hours of results.

This simulation of executive problems may have far-reaching consequences in gaining insight into industrial operations and testing executive qualities.

NEW FROM GENERAL ELECTRIC . . .

52% MORE USABLE PANEL SPACE

GENERAL ELECTRIC'S NEW PYROMETER SAVES SPACE WITH PRINTED CIRCUITS AND MINIATURE COMPONENTS

A new pyrometer that fulfills industrial heat treating requirements of close reproducible control at low cost is now available from General Electric.

THE SMALLER SIZE of the new HP-30 Series Pyrometer means that valuable panel space can be conserved. The size reduction of the instrument was made possible through use of printed circuits, high strength magnet material, and miniature components.

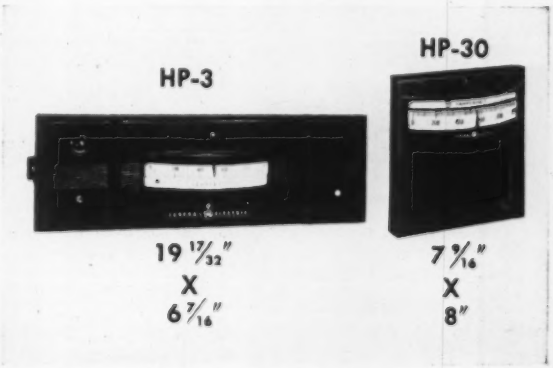
AN EXCLUSIVE FEATURE of General Electric's new pyrometer is automatic lead length compensation. The HP-30 offers lead length compensation up to 25 ohms in low ranges and 90 ohms in higher ranges.

HIGH ACCURACY and control sensitivity are maintained at levels associated with General Electric's HP-3 Pyrometer. The new instrument features ±.5% accuracy and .1% to .5% sensitivity adjustment.

EASY CONNECTIONS are possible with the HP-30 because it features knockouts on the top and side of the controller case. Electrical connections may be made to the front or back of a printed circuit board.

FLEXIBILITY of the new pyrometer allows flush or surface mounting, interchangeable control forms, and range changes that can be made in the field. In addition to six basic control forms, special variations to solve specific control problems are available on request.

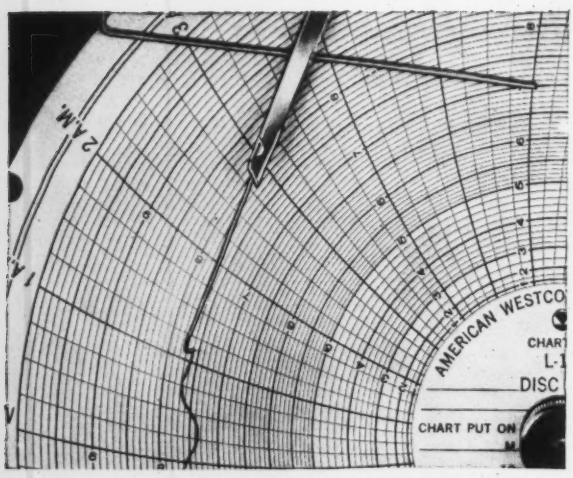
For further information, write to Section 587-8, General Electric Company, Schenectady 5, N. Y., or contact your nearest General Electric Apparatus Sales Office.



COSTLY PANEL SPACE can be saved with the new HP-30—companion to the widely accepted HP-3. Both General Electric instruments feature high accuracy and close reproducible control.

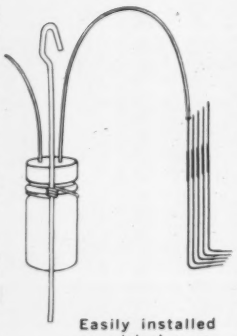
GENERAL ELECTRIC

For more information circle **31** on inquiry card.



CANNON PENS

assure legible charts ...eliminate inking problems



Easily installed as original or replacement equipment in all standard recording instruments. Available in five sizes and angles — special pens upon request.

Cannon controlled-flow capillary meter pens provide exceptional dependability and long life with minimum maintenance. Easy to install, these precision pens produce accurate chart records of maximum legibility and continuously record up to a full year without refilling reservoir.

- **Ends Unrecorded Intervals.** Unaffected by pulsating flows, chart speeds, rapid pen movement.
- **Sealed Ink Supply.** Prevents clogging from atmospheric contamination.
- **Two-Way Ink Flow.** Stainless steel writing point is positioned above ink level in reservoir and ink flows in either direction by capillary action—eliminates smearing, blurring.
- **Special Pens.** Designed and produced to customer specifications where special inking problems make standard pens impractical.

Write today for information

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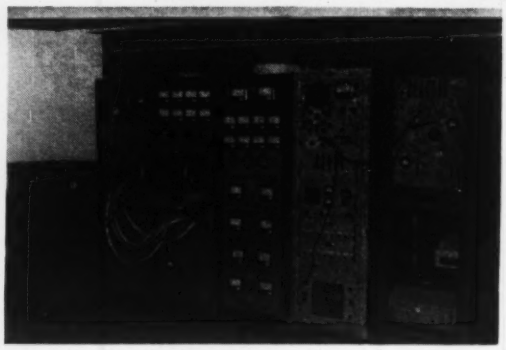
SUPPLIERS TO THE GAS INDUSTRY for Ironcase, Tinned Steelcase, Aluminumcase and Welded Steelcase Meters • American-Westcott Orifice Meters Instruments • Reliance Regulators • Apparatus • Valves

For more information circle **32** on inquiry card.

Programmed Test Set

N. HOLLYWOOD.—A semi-automatic programmed test set with digital printed read-out has been developed



by Pacific Div., Bendix Aviation Corp., for use in final testing of missile telemetering packages. The set performs complete final electrical test of a 177 channel FM/FM missile telemetering system in less than one hour.

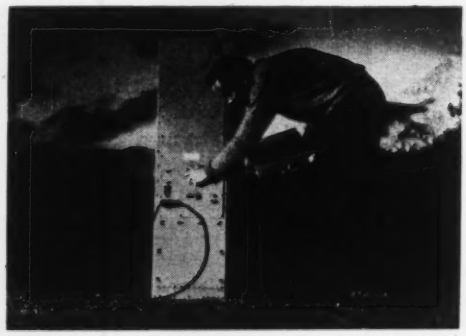
"Pure Signal" CR Tube

CHICAGO, ILL.—*Multi-Tron Laboratory* recently unveiled the first basic design change in cathode-ray tubes since the introduction of electrostatic focusing and deflection. The new tube, called "Pure Signal" tube, is of "multiple beam" design and takes a signal directly from the crystal detector, completely eliminating the necessity for the video amplification circuitry section in any current TV chassis.

The tube operates on multiple modulation of multiple electron beams that intersect to produce a single spot. It gives complete contrast variation from black to white with a signal from 7 to 10 volts peak to peak.

Auroral Study

NORWALK, CONN.—Scientists equipped with Perkin-Elmer's new Auroral Patrol Spectrograph are about to launch a pole-to-pole attack on the age-old mystery—the



aurora. By placing some twenty-three of the instruments from the North to South pole roughly along a given meridian, International-Geophysical-Year scientists will obtain a horizon-to-horizon photographic record of the spectra of auroras along a meridian line and hence have an opportunity to identify predominant atmospheric substances and their changes in composition with time.

The oscilloscope that holds traces indefinitely

HUGHES 104 MEMO-SCOPE* OSCILLOSCOPE

SINGLE OR SUCCESSIVE writings can be retained as permanent transients by the 104 MEMO-SCOPE Oscilloscope until intentionally erased. Stored traces may be almost instantaneously erased by front panel push button or external switch.

THE 104 MEMO-SCOPE Oscilloscope is available in the portable model (illustrated in shock test application), 13" wide, 14" high, 20" deep, or in rack-mounted model with standard 14" X 19" relay panel. Optional plug-in preamplifiers are available for increased flexibility.

TYPICAL APPLICATIONS

Study of transient electrical phenomena.
Presentation of tube or transistor characteristics without necessity of repetition.
Display of frequency response curves without the need of a repetitive sweep generator.
Spectrum analysis.
Shock testing.
Detection and measurement of relay bounce or contact noise.
High-speed or low-speed X-Y plotting.
Investigation of transient behavior of power supply regulation.
Study of camera shutter curves.

Now you can leisurely view, analyze and compare electrical phenomena lasting no longer than microseconds or minutes...without resorting to photography!

The new Hughes-developed MEMO-SCOPE instrument is a self-contained storage-type oscilloscope which combines the distinct advantage of information retention with the features of a superior quality laboratory oscilloscope.

Because of the high visibility of its brilliant displays, the MEMO-SCOPE Oscilloscope can be used in a well-lighted room without the aid of a viewing hood...where single transients or any number of successive waveforms may be studied at will and photographed as desired.
A hinged camera mount swings photographic apparatus aside for direct-display views.

For additional information or demonstration of the new Model 104, write to HUGHES PRODUCTS • MEMO-SCOPE OSCILLOSCOPE
International Airport Station, Los Angeles 45, California

**HUGHES PRODUCTS*

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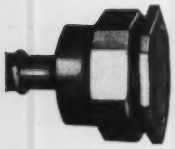
CONTROL WITHOUT CONTACT!

for non-conductive and semi-conductive materials—powders, semi-solids, viscous and corrosive liquids

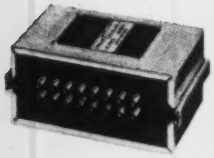
Level tolerances as close as a fraction of an inch —or as great as several feet

This versatile, sensitive probe serves in dozens of *different* applications. It can be mounted vertically or horizontally depending upon the type of control required.



Excel Flush Probe is especially suited for control of abrasives, powders and other semi-solid materials. No moving parts. Nothing extends into bin or hopper.

EXCEL PROXIMITY RELAY



Complete circuit including DPDT relay is in this plug-in unit. Fits only the *right* way. No wires to disconnect. Interchangeable Plug-in Units eliminate down-time.

The Excel Proximity Relay is activated by a change in capacitance at a remote probe caused by the proximity of the movable material to be controlled.

A built-in power relay controls motor starters, solenoids, valves or signals making level control automatic. Complete instrument controls include a test button, relay position lights, and meter for accurate setting of sensitivity and balance. Exclusive coaxial cable (50' max.) connects relay and probe.

What Kind of Material Do You Want to Control?

Petroleum, food oils, grains, glue, sand, core and cutting oils, chemicals, acids and plastics are but a few of the materials that Excel Proximity Relays are controlling automatically for industry now.

The Excel Relay can solve problems for you also. Excel Engineers' experience is available to you without obligation. Write today giving details of your applications. Or write for Bulletin S-256 and Application Data Sheets.

XL-WAY

Service Since 1927

EXCEL
ELECTRIC SERVICE CO.
2129 S. Western Avenue
Chicago 8, Illinois

For more information circle **34** on inquiry card.

NEWS—CONTINUED

Mass-Produced Movements

CHESTERLAND, OHIO—A 25,000-unit order for Model 253-E, a D'Arsonval meter with full-scale range

of zero to 20 microamperes, has made feasible a conveyor-belt assembly line at Assembly Products, Inc. New model has been added to company's large line of indicator movements.

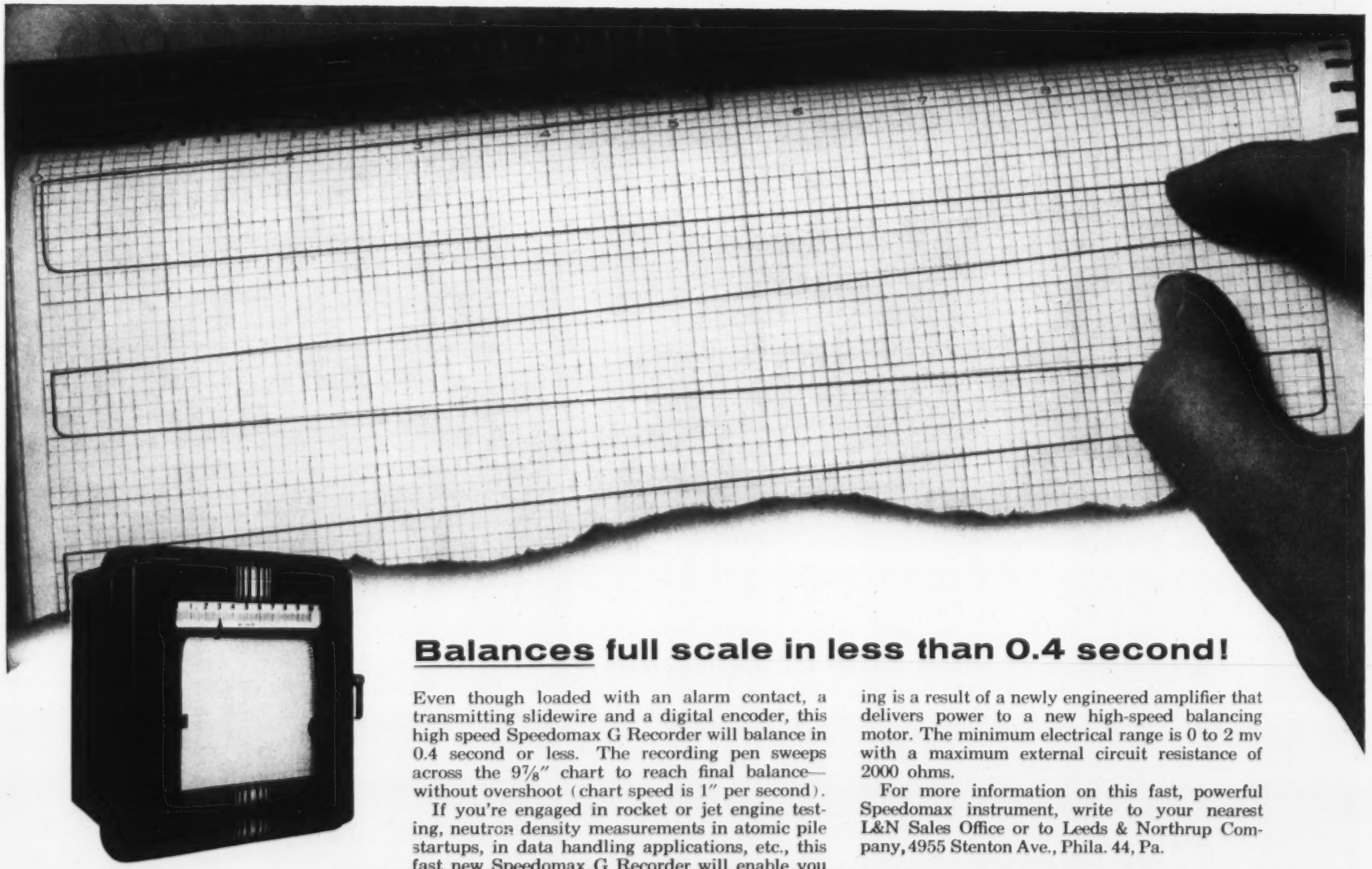
Ocean Floor Exploration

NEW YORK, N. Y.—Socony Mobil Oil Co. has developed a tool for exploring the ocean floor and sediments 80 feet or more beneath it. Called the Sonoprobe, the instrument is similar to conventional recording echo sounders except that is uses pulses of lower frequency and greater power. The sea floor and layers beneath it are displayed on a small TV picture tube and are also recorded as a continuous profile on electrosensitive paper.

Education News

PITTSBURGH, PA.—Engineering and Scientific Societies are extending efforts to recruit more technical talent:

- The American Society for Engineering Education (*ASEE*) recommends measures to improve high-school science teaching by (1) encouraging teachers to improve themselves, (2) giving them more help by better equipment, (3) finding better qualified teachers, (4) making science courses more attractive to students, and (5) re-evaluating teacher-training requirements.
- *SEG* (Society of Exploration Geophysicists) will distribute more than $8000 for scholarships this year. All are grants by 5 companies interested in the field.
- *SAMA* conducted a study and found that only about 9% of high-school guidance counselors have a science background themselves. The report on the study states that "considering that 91% of the nation's high school guidance people have non-science backgrounds, it is certainly to their credit that science is so well recognized as a promising vocational area" . . . .
- Encouraging news from the *AEC*: 300 applications for graduate fellowships in nuclear technology (see *I&A*, December 1956) have been received by the Commission for the expected 150 annual fellowship appointments. Grants awarded so far by the AEC to aid nuclear technology training include 15 American educational institutions and amount to nearly $1.2 million.
- Daystrom Nuclear Div. has devised a training program for reactor operators or instructors to go with the sale of their "fail-safe" 10-kw "Argonaut" reactors especially designed for universities and industrial research.



Balances full scale in less than 0.4 second!

Even though loaded with an alarm contact, a transmitting slidewire and a digital encoder, this high speed Speedomax G Recorder will balance in 0.4 second or less. The recording pen sweeps across the 9⅞″ chart to reach final balance—without overshoot (chart speed is 1″ per second).

If you're engaged in rocket or jet engine testing, neutron density measurements in atomic pile startups, in data handling applications, etc., this fast new Speedomax G Recorder will enable you to measure and record extremely fast changes in the d-c millivolt signal under test.

This fast balancing speed with instrument loading is a result of a newly engineered amplifier that delivers power to a new high-speed balancing motor. The minimum electrical range is 0 to 2 mv with a maximum external circuit resistance of 2000 ohms.

For more information on this fast, powerful Speedomax instrument, write to your nearest L&N Sales Office or to Leeds & Northrup Company, 4955 Stenton Ave., Phila. 44, Pa.

LEEDS Instruments NORTHRUP Automatic Controls • Furnaces

For more information circle **35** on inquiry card.

* Photo shows a JOY No. 372M electrical connector absorbing the full impact of a heavily swung 10 lb. sledge hammer. After 24 similar blows, this plug was carefully tested. Results, no damage electrically and only slight abrasions on its Neoprene jacketing. *However this test illustrates only one* of many important reasons why JOY plugs and receptacles have become such industrial favorites. Factory molded as tough one-piece Neoprene jacketed units, they're shatter-proof, water-tight and long-lasting. Grease or oils won't make them mushy. When connectors are engaged closely fitted face segments enclose contacts in a protective Neoprene housing, protecting them from airborne particles of metal or dust. Why accept less — when the best actually *costs less* in the long run. Write for full details including a copy of Bulletin MC108, today.

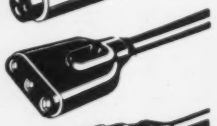
A DESIGN FOR EVERY NEED

(1) PUSH-LOCK DESIGN
A twist of the wrist locks them together. No. 1B375M illustrated.

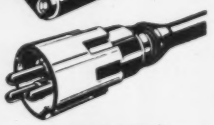
(2) PUSH-LATCH DESIGN
Best for small tools and lighting. No. B2B187M illustrated.

(3) ROUND DESIGNS
Excellent for many standard uses. No. 3A125F illustrated.

(4) OVAL DESIGNS
Lay flat. Offer less obstruction. Favorites. No. 330F illustrated.



(5) (S.P.B.) DESIGNS
For heavier currents. Have threaded couplings. No. D3D625M illustrated.



Write for complete information today!

Ask for your free copy of Bulletin MC-108 describing many of JOY'S outstanding Electrical Connectors in detail. It will be mailed promptly without obligation.

CD 154.2

More than 100 years of Engineering experience

JOY MANUFACTURING COMPANY
ELECTRICAL PRODUCTS DIV. • 1201 MACKLIND AVE. • ST. LOUIS 10, MO.
EXECUTIVE OFFICES, HENRY W. OLIVER BLDG., PITTSBURGH 22, PA.

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NEWS—CONTINUED

► Six Universities have been selected by the Atomic Energy Commission to participate in a program designed to double the number of nuclear reactor specialists trained each year at the Oak Ridge School of Reactor Technology (ORSORT). They are: Carnegie Institute of Technology, Pittsburgh, Pa.; Case Institute of Technology, Cleveland, Ohio; Northwestern University, Evanston, Ill.; University of California, Los Angeles, Calif.; University of Florida, Gainesville, Fla.; Union College, Schenectady, N. Y. Under the expanded ORSORT program the first six months of the one-year course will be given at the participating institutions and the remaining six-months at the Oak Ridge National Laboratory which operates the school for the Commission.

► Encouraging news comes from Maryland as reported by the "Engineering and Scientific Manpower Newsletter.": Enrollments in high school science and mathematics courses are showing a definite upward trend according to a recent survey conducted by the Maryland State Department of Education. Algebra enrollments have almost doubled from a low of 8,700 in 1950 to a high of 16,000 in 1956. This growth is proportionately larger than student body expansion. The survey revealed similar trends in plane and solid geometry, trigonometry, chemistry and physics. In Maryland more than 95% of all county high schools, regardless of size, offer courses in algebra and chemistry. Plane geometry is available in 93% and physics in 90%. On the basis of total enrollments, less than 1% of Maryland high school students do not have algebra and chemistry available and 4% do not have physics available.

► The American Society of Tool Engineers again has offered ten International Education Awards for engineering students interested in pursuing tool and production engineering as a profession. Scholarship awards of $700 each will be made to outstanding engineering students in institutions in the United States and Canada to aid in their fourth (or in some cases, fifth) year of a curriculum which includes tool and production engineering subjects.

► IBM recently opened an exhibit (The "World of Numbers,") at the Museum of Science and Industry in Chicago to show the vital significance of mathematics in our modern world and the many rewarding career opportunities open to those with training in mathematics.

► The plan of "Teaching the Teacher" is picking up more impetus. The National Science Foundation announced 95 summer institutes in 1957 for high school and college teachers of science and mathematics, in colleges and universities throughout the United States and its Territories. Grants totaling $4,800,000 for the support of the summer institutes were announced. Roughly 4500 high-school teachers and 250 college teachers will be enabled to participate in these teacher-training programs.

► DuPont Company announced a fund of more than $1,000,000 for grants to 122 universities and colleges in its annual program of aid to education. It is a substantial increase over the $900,000 in gifts made for last year. Nearly all of the increase and more than half of the entire program are for the improvement of teaching in universities, colleges, and high schools. The grants will support science and mathematics as well as other subjects.

► The Atomic Energy Commission has approved a loan of 5,500 pounds of natural uranium metal, plus neutron

While this missile is in flight...

...telemetered data are recorded and simultaneously played back for computer use

Developed to record and reproduce missile data, Consolidated's new 5-752 Magnetic Tape System is also ideal for wind tunnels, engine test stands—wherever high speed acquisition of large amounts of precise data is essential. A compact, complete Magnetic Tape Recorder and Reproducer System housed in one steel cabinet, the 5-752 handles analog, PDM, and FM signals... provides seven individual tape tracks for simultaneous recording of separate signals on ½-inch tape. It also handles ¼, ¾, and 1-inch tape widths with a capacity of 5000 feet of 1.5-mil tape.

CEC's new magnetic

TAPE RECORDER/REPRODUCER SYSTEM

Frequency range of the 5-752 is from 0 cycles to 100 kc. Six tape speeds are provided in three groups—60 and 30 ips, 15 and 7.5 ips, and 3¾ and 1⅞ ips, with switching selectable from the front panel. Contact your nearby CEC field office, or write for Bulletin CEC 1576-X2.

Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena, California

OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

For more information circle **37** on inquiry card.

AUTOMATIC PRESSURE or VACUUM CONTROL J6

UE TYPE J6 PRESSURE & VACUUM CONTROL

UNITED ELECTRIC TYPE J6 unit is designed to automatically control either pressure or vacuum . . . has a fixed, uniform on-off differential as specified between limits of 3" WC to 2 PSI . . . and a maximum controlling pressure of 180 PSI. It is a sensitive, weatherproof, precision built control with good repeatability. Recommended for all pressure or vacuum applications which require close on-off differential control.

Switch Differential	Fixed as specified between limits of 3" WC to 2 PSI.
Switch Ratings	15 or 20 amps at 115 or 230 volts AC, also DC switches upon specification.
Switch Types	N.O., N.C., or Double Throw, no neutral position.
Size	$4\frac{3}{4}$" x $4\frac{27}{32}$" x $2\frac{5}{16}$".
Weight	Approx. 1 lb. 8 oz.
Electrical Connection	$\frac{1}{2}$" NPT conduit opening in enclosure, screw type terminals on switch is standard.
Enclosure	Die-cast aluminum case, black wrinkle finish standard.
Mounting	Surface mounted—by 2 mounting ears.
Bellows	Seamless brass—spring loaded.
Pressure Connection	$\frac{1}{4}$" NPT female connection.

UNITED ELECTRIC *manufactures a complete line of temperature, pressure and vacuum controls. UE will gladly modify or custom-build a unit to your specifications. Consult a UE application engineer today.*

Write for Bulletin No. 5-3 for complete J6 data.

United Electric Controls
COMPANY
SCHOOL STREET WATERTOWN MASS

For more information circle **38** on inquiry card.

NEWS—CONTINUED

sources, to Reed College, Portland, Oregon. The uranium and neutron sources will be used in a subcritical assembly for the training of nuclear engineers.

► Polytechnic Institute of Brooklyn is presenting the first course in the East on the *metallurgy of nuclear power reactor materials*. The course will be offered during the Spring semester to graduate students and professionals working in the field.

► A course in *Electronic Data Processing* for Business and Industry, given last fall in New York's Hotel Roosevelt, is beng repeated in Chicago the end of February. Its emphasis is on the applications aspect of electronic data processing rather than on the details of particular equipment.

Stock Report

Any further information concerning any of the following issues may be obtained from the Research Department, Bache & Co., 36 Wall Street, New York 5, N. Y.

New York Stock Exchange:

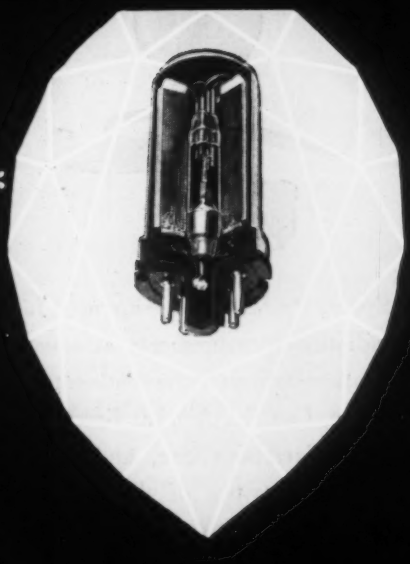
Price Range For 1957
Thru April 15, 1957

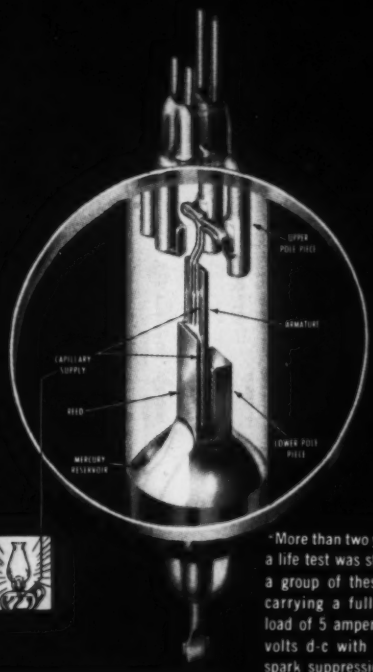
	High	Low	Price as of 4/15/57
ACF Industries	34	33 1/2	33 3/4
Aeroquip Corp.	27 1/4	26 1/2	26 1/2
Allis Chalmers	35 1/2	34	34 1/8
American Chain & Cable	53 3/4	51 3/4	51 1/8
American Machine & Foundry	38 7/8	37 5/8	38 1/8
American Machine & Metals	43 1/4	41	42 1/4
American Optical	33 3/4	33	33 1/4
American Tel. & Tel.	174 7/8	170 1/2	172 3/4
Beckman Instruments	47	45 1/4	45
Bell & Howell	50 1/2	48 1/2	48 1/4
Bendix Aviation	58 1/4	57 1/2	58 1/2
Boeing Airplane	41 1/4	40	41 1/2
Bullard	39	38 1/8	38 1/8
Bulova Watch	31	30 3/4	30 7/8
Burroughs	41 3/8	39 7/8	41 1/8
Carborundum	45 5/8	43 3/4	44
Cincinnati Milling Machine	50 1/2	48 3/4	49 1/2
Clevite	31	28	30 1/8
Columbia Broadcasting 'A'	35 7/8	34 3/4	34 3/4
Consolidated Electronics	31 1/2	29 1/2	29 3/4
Cornell Dubilier	23 1/2	21	23 3/4
Corning Glass	64 1/2	62 1/4	63 1/4
Curtiss-Wright	37 1/8	35 3/4	36
Cutler Hammer	56 3/4	53 1/2	54
Daystrom	31 1/4	29 1/2	30 1/2
Dobeckmun	21	19 1/2	20 1/2
Douglas Aircraft	51	49 1/2	50 1/4
Eastman Kodak	80 1/2	78 1/4	79 1/2
Eaton Manufacturing	54 1/4	52 1/2	53 3/4
Electric Auto Lite	33 1/2	32 1/4	32 3/4
Elgin Watch	11 1/8	11 1/8	11 1/8
Food Machinery & Chemical	60 1/2	58	58 1/4
Gamewell	26 1/2	25 1/2	25 1/2
Garrett	50	49 1/4	49 1/2
General Dynamics	53 3/4	51 3/4	52 1/2
General Electric	63 3/4	61 1/2	61 3/4
General Instrument	28 1/2	27 3/4	27 3/4
General Mills	64	62 3/4	63 1/4
General Precision Equipment	41 7/8	39 1/2	39 1/2
General Railway Signal	33	32	32
General Telephone	44	43 1/2	43 3/4
General Time	30 1/2	29 1/4	29 3/4
General Tire & Rubber	75 1/8	73 1/4	74
International Business Machines	578	570	577
International Tel. & Tel.	33 3/4	32 1/8	33 3/4
Lockheed Aircraft	57 1/2	55 1/4	55 5/8
Magnavox	32 1/4	29	31 7/8
Minneapolis-Honeywell	37 5/8	35 1/2	37 1/4
Minnesota Mining & Manufacturing	53 3/4	52	53 1/2
Motorola	43 3/4	38 3/4	43 1/2
National Acme	80 1/2	64	76
National Cash Register	56 1/4	54 1/2	54 1/8
North American Aviation	32 1/4	27 1/2	31
Northrop Aircraft	30 1/8	28 1/2	29 1/8
Otis Elevator	46	34 1/8	46
Philco	19 3/8	14 1/8	17 3/4

Continued on page 614

Circle **39** on inquiry card. ⟶

THIS CLARE RELAY IS *practically* FOREVER*





In many applications the right kind of relay will outlast and outperform any other circuit elements.

Even the most eager advocates of static switching systems—where static-magnetic and solid-state elements are used to accomplish functions usually performed by relays and other contact-making devices—now recognize this fact.

The Clare Mercury-Wetted-Contact Relay, for example, has a life of billions* of faultless operations. It requires no maintenance. It can switch from 250 volt-amperes down to a faint whisper of voltage and current. It is the best dry circuit relay in existence. More than that—it is completely free from contact bounce.

THIS is the relay that has become the main reliance of hundreds of leading designers of computing, data-processing and control equipment. For complete information write for Bulletins 120 and 122, C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: 659 Bayview Avenue, Toronto 17. Cable Address: CLARELAY.

CLARE RELAYS

FIRST in the industrial field

*More than two years ago a life test was started on a group of these relays carrying a full contact load of 5 amperes at 50 volts d-c with suitable spark suppression. They have been operating continuously ever since at 5,184,000 operations a day. They are now approaching the 4-billion mark and the end is not yet in sight.

EPLAB

PYRHELIOMETER
For the Measurement of SOLAR RADIATION

Eppley Pyrheliometers are used for solar radiation measurements at ninety-eight weather stations in the continental United States, Canada, Alaska, Greenland, Iceland, Caribbean Sea, and the Pacific Ocean. Sixty-two of these stations are under the direction of the United States Weather Bureau.

The Eppley Pyrheliometer was adopted as standard equipment by the Weather Bureau after considerable experimentation. It was found to be the best instrument so far tested by the Bureau.

Used in conjunction with a suitable recorder, the Eppley Pyrheliometer will provide an accurate and reliable record of total solar and sky radiation on a horizontal surface.

Bulletin No. 2 on Request

THE EPPLEY LABORATORY, INC.

Scientific Instruments

2 Sheffield Ave.

Newport, Rhode Island U. S. A.

For more information circle **40** on inquiry card.

New York Stock Exchange:

Continued from page 834

Radio Corp. of America	36 3/4	31 5/8	36 1/2
Raytheon	20 7/8	16 3/8	20
Rheem Manufacturing	21 1/4	17 3/4	19 1/8
Robertshaw Fulton	30 3/8	25 5/8	29 7/8
Sangamo Electric	35 3/8	31 1/4	33 1/2
Sperry Rand	23 5/8	20	22
Square D	32 7/8	28 1/8	30 1/2
Standard Coil Products	9 3/8	6 1/2	7 7/8
Starrett (L.S.)	73 3/4	62 1/2	70-71 1/2 (1)
Stewart-Warner	40 3/8	31 7/8	40
Sylvania Electric	45 1/4	34 5/8	43 5/8
TelAutograph	8 3/4	6 1/2	6 7/8
Texas Instruments	24 7/8	15 7/8	22 1/2
Thompson Products	87 1/2	64 1/2	86 3/4
Tung-Sol Electric	31 1/4	27 3/8	31
Underwood Corp.	30 3/8	23 3/4	26 3/8
Union Carbide & Carbon	115 1/2	100 5/8	110 7/8
Western Union	20 3/8	18	18 1/8
Westinghouse Air Brake	30 3/8	26 1/2	29 3/4
Westinghouse Electric	58	52 3/8	57 5/8
Worthington Corp.	60 3/8	52 1/4	60 3/8

American Stock Exchange:

Price Range For 1957
Thru April 15, 1957

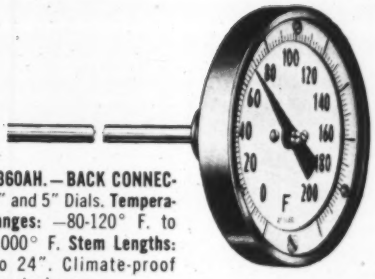
	High	Low	Price as of 4/15/57
Air Associates	11 3/8	8	8 1/2
American Meter	16 1/2	11 1/2	15 1/2
Aro Equipment	26 3/4	17 1/2	19 3/4 - 20 (1)
Barry Controls	11	10 1/4	10 5/8 - 11 1/8 (1)
Telock Instrument	11 5/8	9 1/4	9 7/8
Bonnus Watch	8	5 1/8	7 3/8
Breeze Corp.	7 3/4	5 3/4	7 1/8
Clark Controller	31	25 1/2	27-27 1/2 (1)
Clarostat Mfg.	8	5 1/8	5
Clary Corp.	6 1/2	4 1/4	4 5/8
Consolidated Electrodynamics	41 3/4	31 1/4	41 3/4
DuMont Laboratories	6 1/2	4 5/8	5 1/4
Dynamics Corp. of America	7 5/8	5 3/4	6 1/8
Electronics Corp. of America	12 1/4	9 1/8	11 1/8
El-Tronics	3 1/4	2 1/8	3
Fairchild Camera & Instrument	22 3/8	16	16 1/8
Globe-Union	20 3/4	15 5/8	19 1/2 - 19 3/4 (1)
Hazeltine Corp.	34 7/8	30 1/2	34 3/8
International Resistance	6 1/8	4 7/8	5 1/4
Lear Inc.	8 3/4	7 1/4	7 3/8
Litton Industries	40 3/4	24 1/2	34 1/4
National Research	22 5/8	17 1/2	20 1/4
Neptune Meter	33	27 1/4	27 3/4
New Haven Clock	9/16	1/4	5/16
Norden-Ketay	11 3/8	7 1/8	10 1/4
Nuclear Corp. of America 'A'	2 1/8	3/4	1 3/4
Pneumatic Scale	24 5/8	23 3/4	24 1/8 - 24 7/8 (1)
Reliance Electric	42 1/2	36	41
Servo Corp. of America	5	4 5/8	5 7/8
Servomechanisms	11 1/2	9 1/2	11
United Shoe Machinery	45 7/8	40 1/4	41 1/4
Wallace & Tiernan	32 1/2	25 7/8	29 5/8
Waltham Watch	2 1/8	1 1/2	2 1/8

OVER-THE-COUNTER

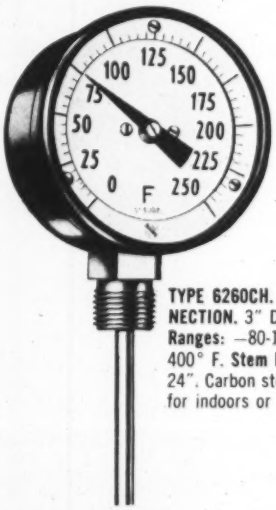
Quotation As Of 4/16/57

	Bid	Asked
Aerovox Corp.	5 1/4	5 3/4
Aircraft Radio Corp.	17 1/4	18 1/2
Argus Corp.	17 3/4	17 1/2
Bitel-McCullough Co.	34 1/2	35 1/2
Electronics Associates	70 1/2	73
Elox Corp. of Michigan 'A'	8 1/4	8 3/4
Elox Corp. of Michigan 'B'	8 1/4	8 3/4
Erie Resistor Corp.	20 3/4	22
G. M. Giannini	18	18 7/8
I-T-E Circuit Breaker	37	37 1/2
Liquidometer Corp.	8	8 1/2
P. R. Mallory & Co.	40 3/4	44 3/4
W. L. Maxson	10 1/2	7
Penn Controls, Inc.	18 1/2	20
Speer Carbon, Inc.	31 3/4	32 3/4
Sprague Electric	32 1/2	35
Taylor Instrument	69 1/2	71 1/2
Telecomputing Corp.	3 1/2	3 7/8
Topp Industries	8 1/2	9
Varian Associates	16 1/4	16 3/4
Vitro Corp. of America	20 5/8	23

(1) Bid-Asked (Not Traded)



TYPE 6360AH.—BACK CONNECTION. 3" and 5" Dials. **Temperature Ranges:** —80-120° F. to +200-1000° F. **Stem Lengths:** 2½" to 24". Climate-proof stainless steel case.

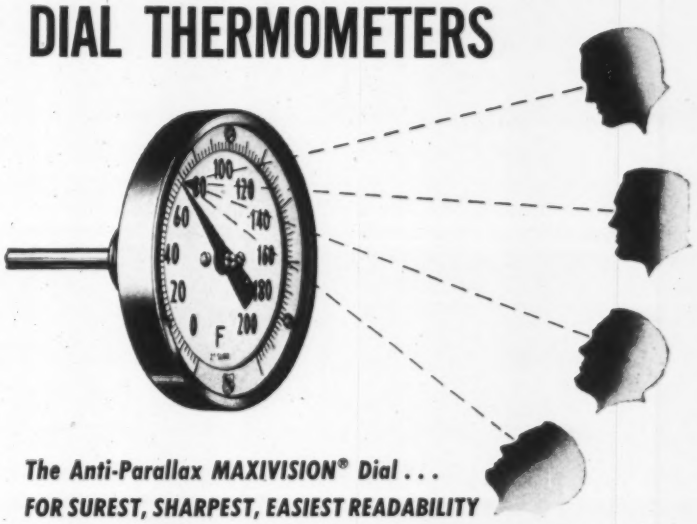


TYPE 6260CH.—BOTTOM CONNECTION. 3" Dial. **Temperature Ranges:** —80-120° F. to +50-400° F. **Stem Lengths:** 2½" to 24". Carbon steel case suitable for indoors or outdoors.

TYPE 6060AH. — "EVERY ANGLE" CONNECTION. 5" Dial. **Temperature Ranges:** —80-120° F. to +200-1000° F. **Stem Lengths:** 4" to 24". Climate-proof stainless steel case.

GET ACCURATE "ON-THE-SPOT" TEMPERATURE READINGS...

INSTALL 'AMERICAN' BI-METAL DIAL THERMOMETERS



The Anti-Parallax MAXIVISION® Dial . . .
FOR SUREST, SHARPEST, EASIEST READABILITY
. . . Is Available Only In 'American' Thermometers

Nowadays fewer men are required in power and processing plants to inspect operations, so it is more important than ever to have observation points handy for them. 'American' Bi-Metal Dial Thermometers, installed at important check points, eliminate frequent trips to the control house. Inspectors can observe variations in process temperatures "on the spot" and take steps to effect corrections.

The economy of these thermometers goes far beyond the time-saving convenience of local indoor and outdoor readings. Their accuracy and utility contribute to lower costs. They provide the greatest sensitivity in bi-metal actuation. The low-mass single helix bi-metal coil is precisely centered in the stem to assure quick, accurate response to all temperature changes — to prevent the retard effect the coil can cause if rubbed against the stem wall.

The Maxivision dial is a split-level dial with pointer set on the same plane as the outside raised ring that carries the graduations. No perspective effect, no parallax! Readings are sure, sharp and accurate at a glance!

The availability of 'American' Bi-Metal Dial Thermometers in types with back, bottom or "Every Angle" connection permits selection to fit the conditions of each location. For example, the "Every Angle" type can be set at any point within 180° on two axes. Thus it is particularly recommended for installation above or below eye level or in close quarters where the types with fixed back or bottom connection would be impractical.

PHONE YOUR INDUSTRIAL SUPPLY DISTRIBUTOR for assistance in selecting the types of 'American Bi-Metal Dial Thermometer best suited to your needs. He can provide separable sockets in al materials and sizes normally required.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

AMERICAN INDUSTRIAL INSTRUMENTS

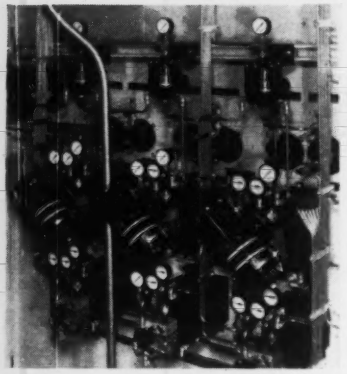
A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONN.

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Okla.* AIRCRAFT CONTROL PRODUCTS, *Danbury, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

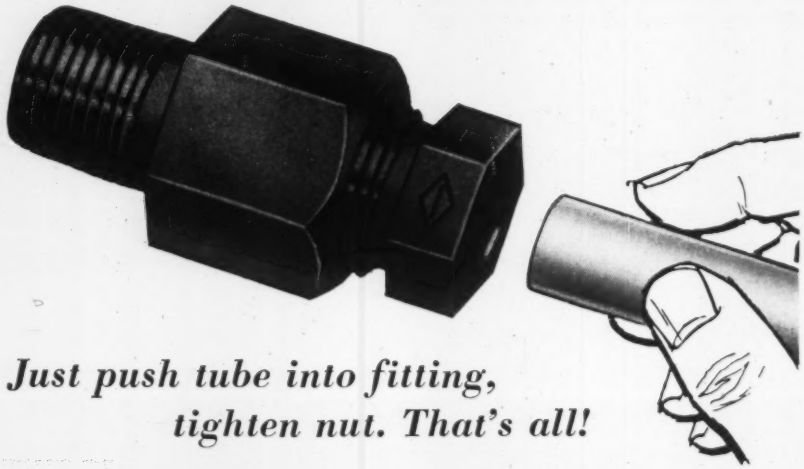
For more information circle **41** on inquiry card.

Cut installation time 36 to 77%

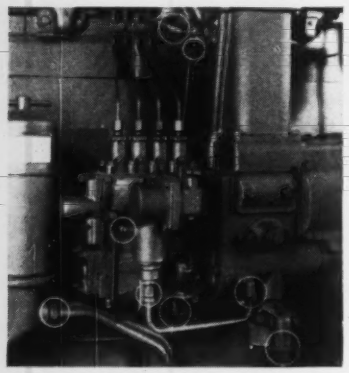
with IMPERIAL *Hi-Duty*® tube fittings



Rear view of a graphic panel used to control a Platform® Unit, built by Panellit Inc., Skokie, Ill.



Just push tube into fitting, tighten nut. That's all!



Millions of Hi-Duty fittings in use on O.E.M., instrumentation and replacement jobs. Hi-Duty fittings can be disconnected and reconnected repeatedly without danger of leakage. Extra-strong forged bodies on elbows and tees, long Dryseal pipe threads and generous hexes. Available in brass and aluminum. For use with copper, brass, aluminum, Bundyweld, GM, block tin, Monel and other metal tubing — ⅛ to 1" O.D.

For complete data, ask for Bulletin No. 3002.

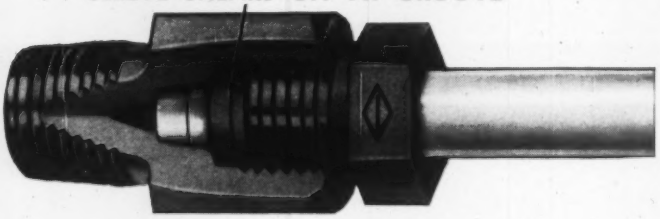
Whether you use 10 Hi-Duty fittings or 500 per installation, seconds saved per fitting will quickly add up to man-hour profits!

Four-to-one edge over flared fittings — A man can easily assemble up to four Hi-Duty fittings in the time it takes to assemble *one* flare fitting. Spot tests show only 11.7 seconds on the average are required to install Hi-Duty as compared with 48.2 seconds for an ordinary flare fitting. A minimum 77% boost in efficiency for you.

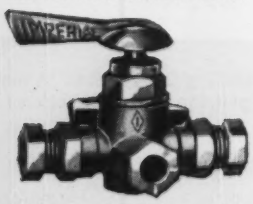
One-third faster than compression fittings — Same tests showed Hi-Duty installation required only 11.7 seconds compared with an average of 18.5 for compression fittings. A boost of 36% in efficiency!

Hi-Duty joints absorb 5 times as much vibration as compression or flare fittings — Sleeve on Hi-Duty fittings shears off during assembly and becomes permanently attached to tube. Always remains in perfect alignment. Joints stay liquid-and-gas tight.

SLEEVE SHEARS OFF AT GROOVE



Furnished in Brass and Aluminum



***Hi-Duty*® SHUT-OFF VALVES — First choice for perfect fluid control! Positive shut-off. Solid bottom — no chance for leakage. Spring-loaded stem with "O" ring seal maintains proper tension on nickel-silver plug at all times. 2, 3 and 4-way types for low and medium pressures.**

IMPERIAL

THE IMPERIAL BRASS MFG. CO.
1204 W. Harrison Street, Chicago 7, Illinois
In Canada: 334 Lauder Avenue, Toronto, Ontario

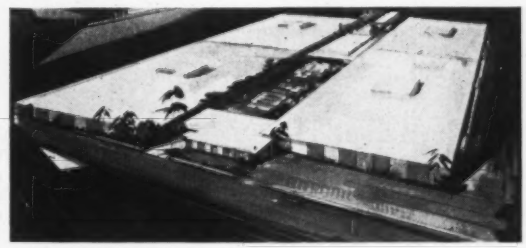
Emblem of Quality

SEE YOUR IMPERIAL DISTRIBUTOR — he carries the industry's most complete line of tube fittings and tubing tools.

For more information circle **42** on inquiry card.

New Plants and Mergers

CONSOLIDATED ELECTRODYNAMICS announces construction of two 57,000-sq-ft office, laboratory and plant buildings to house Transducer and Systems Divisions.



AMERICAN ELECTRONICS' new Division, **AMERICAN LABORATORIES**, announces that its new 11,000-sq-ft plant will begin operation in July.

PHYSICAL MEASUREMENTS, Santa Monica, Calif., is a newly formed corporation providing instruments and systems to measure basic physical phenomena.

C. P. CLARE, which has merged with Universal Products Corp., will continue to operate as a wholly owned subsidiary in form of a separate company.

UNIVERSAL INSTRUMENT BENCH Division of O.K. Machine & Tool Corp. was recently set up to manufacture and distribute the Meyer Universal Instrument Bench.

KEY ELECTRIC CORP. announces new and larger quarters in Port Washington, N. Y. for manufacture of data tape handlers.

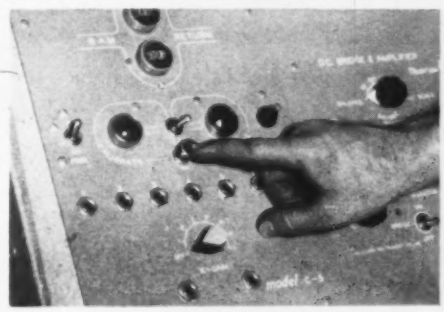
HAGAN CHEMICALS AND CONTROLS will move its headquarters, offices and research center to a 27-acre site on Penn-Lincoln Parkway near Pittsburgh, early in 1958.

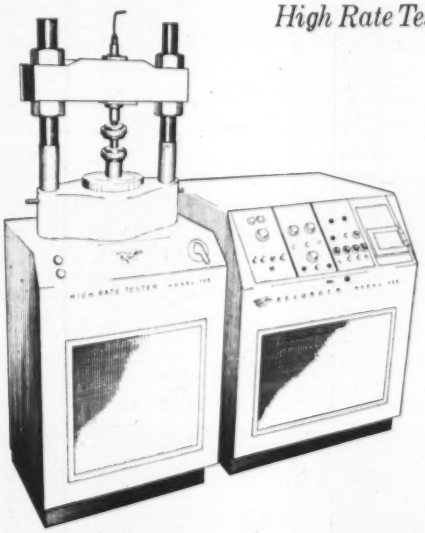
FISCHER & PORTER will become sales agent for Gilbarco Electric Tank Gauge. F&P also announces acquisition of all rights from Olin Mathieson to manufacture the HTH Tablet Hypochlorinator.

SERVOMECHANISMS INC. has opened a new plant of 20,000 sq ft at Hawthorne; a new division, *Vacuum Film Products Div.*, at El Segundo; and has broken ground for a new plant at Westbury, L. I.

TENSILE AND COMPRESSIVE TESTING AT RATES AS HIGH AS 6000 INCHES PER MINUTE

with the ALINCO Model 625 High Rate Tester



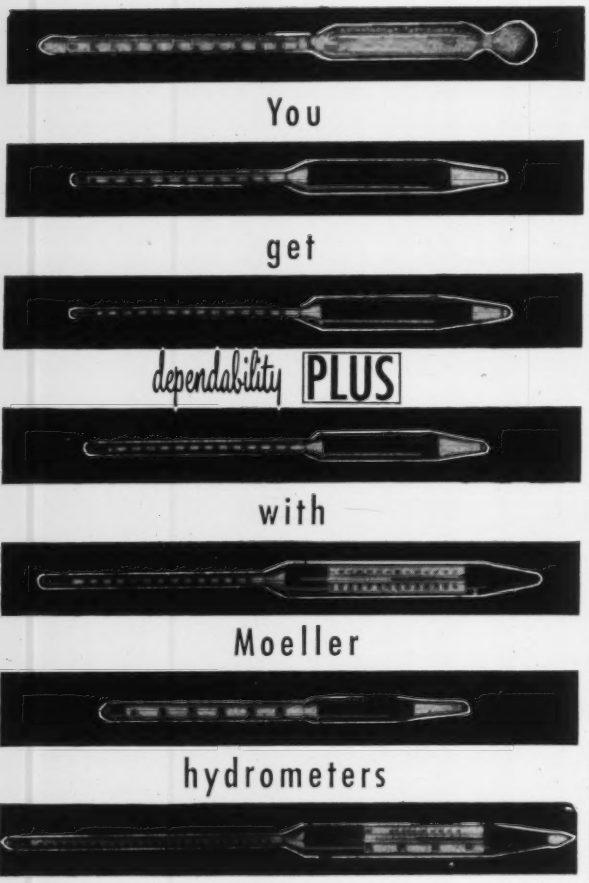


WHEN YOU depress this button, the ALINCO Model 625 High Rate Tensile and Compressive Tester provides you with a single, accurate stress-strain record that will reveal deformation rate, ultimate yield, elastic modulus, effect of deformation rates on elastic modulus and tensile strength, etc., at HIGH or low rates. If you need comprehensive data on the mechanical properties of your materials, write today for detailed literature on this new tester.

ALLEGANY INSTRUMENT COMPANY, INC.
EASTERN DIVISION: 1091 WILLS MOUNTAIN CUMBERLAND, MARYLAND
WESTERN DIVISION: 1052 WEST 6TH STREET LOS ANGELES 17, CAL.

ALINCO

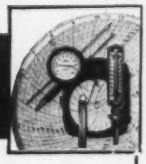
For more information circle **43** on inquiry card.



because the design and manufacture of instruments that measure the density of liquids has been our business since 1867

Moeller Hydrometers are stocked in all standard scales—Brix, Twaddle, Ballings, A.P.I., etc., in plain form or combined with thermometers. *Mail coupon for the Moeller Hydrometer Catalog, today!*

MOELLER INSTRUMENT COMPANY
132nd ST. and 89th AVE.
RICHMOND HILL 18, N. Y.
Representatives in Principal Cities



Gentlemen: Without obligation, please send me Moeller Catalog No. 800 on Hydrometers.

NAME .....

FIRM .....

ADDRESS .....

CITY ..... ZONE ..... STATE .....

For more information circle **44** on inquiry card.

PLANTS—CONTINUED

DIGITRONICS CORP., Long Island City, recently organized for development work in the field of digital computers, is headed by *Albert A. Auerbach, Norman Grieser, Eugene Leonard,* and *Robert F. Shaw.*

PACKARD-BELL COMPUTER CORP., an affiliate of Packard-Bell Electronics, was recently established in W. Los Angeles. The program is research and development in the digital computer field.

SINCLAIR-COLLINS VALVE and **VALVAIR CORP.** announce plant additions to house general engineering and methods engineering departments at Akron, Ohio.

ROBERTSHAW-FULTON announces construction to start on new Western Research Center.

ATLANTIC RESEARCH announces acquisition of U. S. Flare Corp.

TEXAS INSTRUMENTS INC. announces Houston Technical Labs. and Wm. I. Mann Co., two wholly-owned subsidiaries, have become operating divisions now named respectively Industrial Instrumentation and Optics Divisions.

NORDEN-KETAY CORP. plans an extension to the Commack plant of the Precision Components Div.

BORG EQUIPMENT DIV. announces purchase of the Aerovox Hi-Trim Potentiometer now named Borg Micropot.

STAVID ENGINEERING, INC., announces opening a West Coast office at Los Angeles headed by Zachary K. Geanes.

GENERAL TELEPHONE CORP. announces formation of General Telephone Labs., Inc., through acquisition of the research personnel and facilities of Automatic Electric Co.

NUCLEAR-ELECTRONICS CORP. has added an 8000-sq-ft production area to accommodate a 100% increase in business.

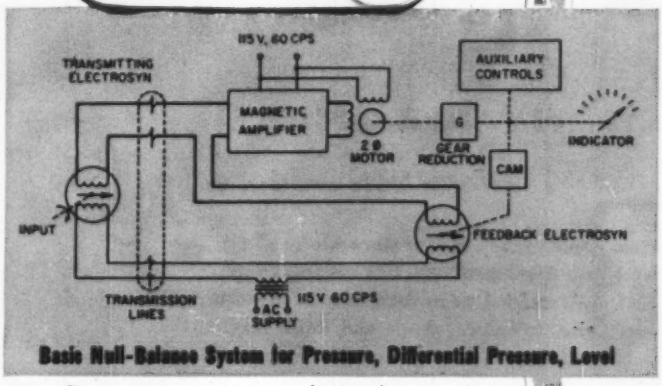
LANGEVIN MFG. CORP., Long Island City, announces consolidation of sales engineering and customer service with the Maxson Instruments Div. of the W. L. Maxson Corp.

E. & S. OPTICAL CO., announces entire facilities have been moved from Hoboken, N. J. to Oak Ridge, N. J.

PACIFIC SCIENTIFIC CO. announces a name change for its manufacturing affiliate in Glendale, Calif. Sturgess, Inc., has been changed to Pacific Scientific Aeroproducts.

MAGNETIC AMPLIFIERS, INC., New York, has opened a West Coast division in El Segundo, Calif.

ElectroSyn Pressure Transmitter Model 501



Basic Null-Balance System for Pressure, Differential Pressure, Level

Basic system consists of signal transmitter, magnetic servo amplifier, null-balance indicator. (No electron tubes or slide wires.)

In measuring pressure the Model 501 transmitter utilizes a twisted bourdon tube as the pressure sensing element. This tube converts the pressure into shaft rotation of the ElectroSyn, a rotary differential transformer. Output from the ElectroSyn is an a-c voltage exactly proportional to the measured pressure.

HIGHer reliability
LOWer maintenance

- *pressure*
- *differential pressure*
- *flow*
- *level*
- *temperature*

ELECTROSYN SYSTEM

ElectroSyn is a highly flexible, extremely rugged electro-magnetic system for a wide range of applications in the chemical processing, atomic power, natural gas and petroleum transmission fields. It is designed to measure, indicate, record (including analog to digital conversions), or control pressure, differential pressure, flow, liquid level, temperature.

Leading pipeline companies are using ElectroSyn systems for remote indication and data handling of pressures and flows because of system's reliability, flexibility and the fact that it can withstand a static overload of 300% of rated pressure for a 1% zero shift. For complete information write for Technical Bulletin B257.

NORWOOD CONTROLS
UNIT OF DETROIT CONTROLS CORPORATION
937 Washington Street, Norwood, Mass.

NORWOOD CONTROLS

Copyright 1957 Detroit Controls Corp.

For more information circle 45 on inquiry card.

CRUCIBLE PERMANENT MAGNETS

give maximum energy . . . minimum size

Crucible *prescription-made* Alnico permanent magnets provide *consistently higher* energy products.

This means greater design freedom . . . more compact products for manufacturers of high-fidelity sound equipment, instruments, controls, motors, and other magnet equipped devices.

Crucible has been a leading producer of these quality magnets ever since Alnico alloys were first developed. You can get them sand cast, shell molded, or investment cast to meet every size, tolerance, shape and finish need.

Next time you need top quality magnets, or help with magnet applications, call Crucible. *Crucible Steel Company of America, Henry W. Oliver Building, Pittsburgh 30, Pa.*

Crucible Steel Company of America

CRUCIBLE first name in special purpose steels

For more information circle **46** on inquiry card.

J. SAINT-AMOUR
Assembly Prod.

M. G. CALHOUN
Fulton Sylphon

H. A. FINKE
Polytechnic Res.

W. A. McCARTHY
Victoreen

People IN THE NEWS

DAYSTROM INC. announces election of *Thomas Allinson* to vice president, marketing, and appointment of *David Taylor* as staff engineer, instrumentation, at La Jolla, Calif.

ASSEMBLY PRODUCTS has elected *John Saint-Amour* as president, *Robert H. Pugsley* as vice president, and *Bradley R. Thompson* chairman of the board.

FULTON SYLPHON DIV. announces appointment of *Marvin G. Calhoun* as supervisor, bellows sales.

POLYTECHNIC RESEARCH AND DEVELOPMENT CO. announces advancement of *Herbert A. Finke* to general manager.

VICTOREEN announces appointment of *William A. McCarthy* as sales manager.

ARNOUX CORP. announces election of *Richard W. Hodgson* to executive vice president; and *Walter Y. Fish* to vice president, engineering.

ASKANIA REGULATOR CO. announces appointment of *G. L. Stancliffe, Jr.*, as vice president and general manager.

POTTER INSTRUMENT announces election of *Edward D. Gray* as vice president.

NORWOOD CONTROLS has enlarged its sales department which will be headed by *Michael D. Altfillisch.*

KINTEL elected *LaMotte T. Cohu* to head its newly formed subsidiary Cohu Electronics Inc.

MINE SAFETY APPLIANCES announces election of *John B. Davies* to assistant vice president; *C. M. Donahue* and *E. W. Merry* were selected group vice presidents.

BAIRD-ATOMIC announces election of *Dr. Davis R. Dewey II* as president.

NORDEN-KETAY has appointed *Bernard Levine* as vice president.

DEHYDRATION
OF GASES
HI-LO PRESSURES
HI-LO FLOWS

"PAT. PEND."

- New Leakproof Design — Chambers and Cartridges "O" Ring sealed, no possibility of gas bypassing the cartridge.
- No tools required to change cartride or Mechanical Filter Element for cleaning.
- Manual or Automatic Units. Portable, stationary or airborne installations.

ROBBINS AVIATION

WRITE FOR BULLETIN

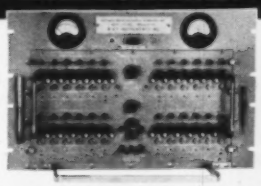
1735 W. FLORENCE AVE. LOS ANGELES 47, CALIF.

For more information circle **47** on inquiry card.

new B & F Strain Gage Control Unit permits

DATA REDUCTION

FASTER . . . EASIER . . . MORE ACCURATELY



B & F Bridge-Balance and Calibrating Unit, Model 24-202, is a precision-built instrument for the balance, control and SERIES calibration of strain gages, accelerometers, pressure pickups and other resistive-type transducers.

Proving invaluable today in missile range instrumentation systems and flight test programs of advanced military aircraft, the Model 24-202 eliminates the need for "averaging through" calibration pulses or "fairing" zero and base line references.

FEATURES:

Independent adjustment for each channel of:

- VOLTAGE—(Individual Channel Control Switches)
- BALANCE
- GALVANOMETER DAMPING (SHUNT and SERIES)
- SENSITIVITY
- CALIBRATING LEVEL and PHASE

For complete details on this or other models with 6, 12 and 18 channels, write, wire or call.

B&F instruments, Inc.

4732 N. Broad Street
Philadelphia 41, Pa.
DAvenport 9-2828

other products: Torque Meter Systems, Accelerometers

For more information circle **48** on inquiry card.

Precise

TEMPERATURE MEASUREMENTS

. . . with the Rubicon

MUELLER BRIDGE

A highly accurate and specialized form of the Wheatstone bridge designed expressly for precise resistance thermometry with three- or four-lead thermometers and for the measurement of other similar resistors within its range.

- Wide range: 0 to 141.1110 ohms in increments of 0.0001 ohm
- Unity ratio with provision for convenient checking and precise adjustment of ratio arms
- Built-in mercury commutator for lead resistance compensation
- Sub-panel switch construction
- Built-in plug and block assembly for conveniently checking ratio, bridge zero and thermometer resistance with no disturbance of external bridge connections

Described in Bulletin 100

. . . with the Rubicon

PORTABLE PRECISION POTENTIOMETER

A two-dial instrument of exceptional accuracy and sensitivity.

- High-sensitivity, sturdy, built-in Pointerlite galvanometer —permits balancing to within 2 microvolts in low resistance circuits
- Completely self-contained assembly—no external accessories except the thermocouple circuit
- Two ranges —0 to 16.1 and 0 to 161 millivolts—readable to within 2 and 20 microvolts respectively
- Sturdy, compact construction for long dependable service

Described in Bulletin 270

RUBICON COMPANY

Electrical Instrument Makers

3755 Ridge Avenue Philadelphia 32, Pa.

For more information circle **49** on inquiry card.

PEOPLE—CONTINUED

A. B. POWELL
Mason-Neilan

ELECTRODATA DIV., Burroughs Corp., announces appointment of *J. F. Kalbach* as field engineering manager.

TUBE TURNS PLASTIC, INC., announces appointment of *Earl Erich* as sales manager.

MASON-NEILAN, Division of Worthington Corp. announces promotion of *A. Blair Powell* from Pittsburgh office manager to general sales manager of the division.

THE FOXBORO CO., announces appointment of *Ralph Hayden, Jr.*, as manager of purchases and traffic, *Richard M. Kimball* will serve as consultant on procurement problems.

FEMCO, INC., announces appointments of five district sales managers: *John W. Bauer, Jr.*, Western Pa.; *John Taylor*, Cleveland, Youngstown, Buffalo; *Addison Davidson, Jr.*, Eastern U. S.; *Warren C. Sprague*, West Coast; James Beaven, Southern U. S.

ELECTRO-PULSE, INC., Culver City, Calif., announces appointment of *Dr. Norman H. Enenstein* as vice president and director of engineering.

AMPEX CORP., Redwood City, Calif., has appointed *John Jipp* manager of the Instrumentation Div.

BARBER-COLMAN CO., Wheelco Instruments Div., announces new sales office heads: *Harold Dirkers*, St. Louis; *Howard Berger*, Cleveland; *Stanley Hanson*, Detroit.

JAS. P. MARSH CORP. announces *F. O. Pauls* is now advertising manager.

BECKMAN INSTRUMENTS-SCIENTIFIC INSTRUMENTS DIV. announces appointment of *Walter Donner* as assistant director of research and engineering.

BJ ELECTRONICS has a new chief engineer: *Orrin C. Bowers* was appointed to the post.

GENERAL CONTROLS CO. announces appointment of *Chester S. Beard* (known to our readers from his Control-Valve series) as chief of the Control Valves and Actuators Engrg. Div.

CONSOLIDATED ELECTRODYNAMICS CORP. announces two appointments for its new Glendale Div. (formerly R. A. Castell & Co.): *Donald E. Brown* has become chief engineer, and *Frank E. Chase* is manager of sales.

PANELLIT, INC. has appointed *G. A. Walley* chief engineer of the newly-opened Alhambra, Calif., manufacturing facilities.

EPSCO, INCORPORATED announces new appointees: *L. C. Arnold* as manager of manufacturing, *E. B. Haynes* as production manager, and *T. G. Hagan* as project engineer.

a Bendix Computer solves another tough engineering problem...

problem:

Pacific Air Industries, a leader in the field of making contour maps from aerial photographs, needed a faster way to compute control points for their stereoplanigraph. Highway construction could be greatly speeded if the goal was met.

solution:

Donald Lewis, P.A.I. partner, writes: "We had such poor results with other computers, we considered Bendix with great scepticism... but we have now completely resolved our problem through use of the Bendix G-15 General Purpose Digital Computer. We repeatedly solve this type of problem, which previously required the work of two mathematicians for 18 hours, in less than one hour, and with no chance of error. We are now developing other uses."

Typical of benefits to the aviation industry through a purchased or leased electronic computer? Definitely. In many cases the BENDIX G-15 has even solved problems where a solution seemed impossible before. If you seek faster, more accurate research or design calculations, why not talk things over with a BENDIX Computer Sales Engineer? You don't need to have a specific problem in mind to get the advantage of his experience. Just use the coupon below.

Bendix Computer

DIVISION of BENDIX AVIATION CORPORATION
5630 ARBOR VITAE STREET • LOS ANGELES 45, CALIFORNIA
OFFICES IN WASHINGTON, D.C., DALLAS, LOS ANGELES AND CHICAGO

Export Representatives
Computing Devices of Canada, P. O. Box 508, Ottawa 4, Ontario
Bendix International Division, 205 E. 42nd Street, New York 17, N.Y.

BENDIX COMPUTER DIVISION—BENDIX AVIATION CORPORATION
5630 ARBOR VITAE STREET, LOS ANGELES 45, CALIFORNIA

☐ *Please contact me for an appointment to discuss engineering applications of the G-15.* ☐ *Send literature.*

NAME_____

TITLE_____

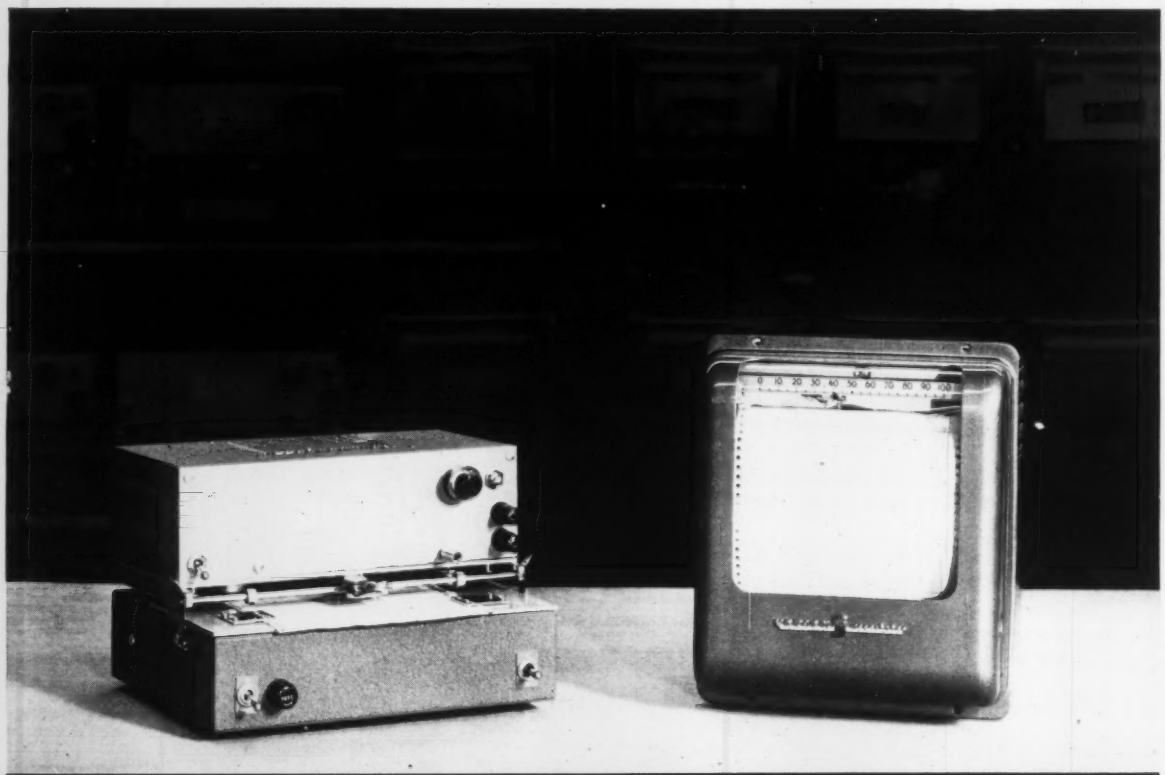
COMPANY_____

ADDRESS_____

For more information circle **50** on inquiry card.

Varian Strip Chart Recorders

POTENTIOMETER PERFORMANCE* AT MODERATE COST



Varian G-10 — Portable for laboratory or bench use where chart accessibility is of prime importance. Base price $340.

Varian G-11 — For panel, rack or portable use; designed for OEM, lab or field for long-term monitoring. Base price $450.

* The servo-balance potentiometer method has long been used in expensive recorders to achieve superior stability, sensitivity, ruggedness and high input impedance. Use of servo balancing systems assures full realization of these inherent advantages by providing ample power independent of the source being measured. Now Varian offers you recorders of moderate cost using this time-proven principle.

VARIAN SPECIFICATIONS:

- Spans as low as 10 mv
- Limit of error 1%
- Maximum source resistance 50K ohms or higher
- Balancing times: 1 second or 2.5 seconds on G-10; 1 second on G-11

WRITE TODAY FOR COMPLETE SPECIFICATIONS

Varian recorders are sold and serviced throughout the free world by representatives in principal cities.

VARIAN associates
INSTRUMENT DIVISION
PALO ALTO 27, CALIFORNIA

Varian Associates manufactures Klystrons, Traveling Wave Tubes, Backward Wave Oscillators, Linear Accelerators, Microwave System Components, R. F. Spectrometers, Magnets, Magnetometers, Stalos, Power Amplifiers and Graphic Recorders and offers research and development services.

For more information circle **51** on inquiry card.

SIGNIFICANCE

PERHAPS the greatest significance of our "Biography of Significance" this month is its recognition of the work done by dedicated civil servants. Dr. Harold K. Skramstad has been with the National Bureau of Standards ever since he received his Ph. D. in 1935.

As assistant Chief, Data Processing Systems Division, he is now responsible for work in analog computation, simulation, and automatic control. He was the first chairman of the Eastern Simulation Council (1955) and a driving force behind the National (now International) Simulation Councils. We are proud to acknowledge Harold Skramstad's many pioneering achievements in various fields of instrumentation.

DR. HAROLD K. SKRAMSTAD

DR. HAROLD K. SKRAMSTAD received his B.S. from the College of Puget Sound, Tacoma, Washington in 1930. From 1931 to 1935 he held a teaching fellow in the physics Department, University of Washington, Seattle, where he received his Ph. D. in 1935.

His first assignment upon joining the National Bureau of Standards included research in aerodynamics, wind tunnel turbulence, and boundary layer flow. His work and that of his co-worker, Dr. G. B. Schubauer, led to the original discovery of laminar boundary-layer oscillations, whose mathematical theory had been worked out previously. For this discovery he received jointly with Dr. Schubauer the Sylvanus Albert Reed award of the Institute of Aeronautical Sciences in 1948.

During World War II he pioneered in guided-missile development, playing a key role in the development of the "Bat" guided missile. The "Bat" was a radar-homing glide bomb, released from patrol bombers, and automatically guided to home on enemy ship targets by a radar contained in the nose of the missile. For this work he received the Navy Bureau of Ordnance Execptional Service Award in 1945.

In 1946, he was designated Chief, Guided Missiles Section, becoming Assistant Chief, Missile Development Division in 1950. He was in charge of the aerodynamics, stabilization and control development of the 'Kingfisher' series of missiles. He also pioneered in the field of analog computation and simulation, establishing at NBS one of the first flight simulator facilities in existence.

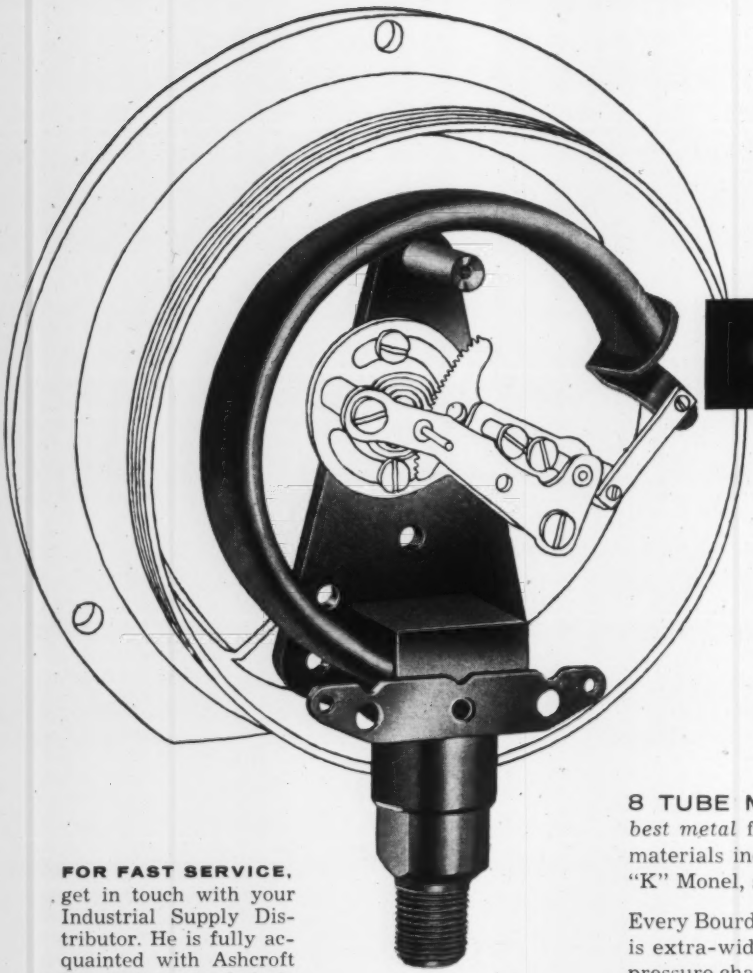
In 1951 guided-missile work was transferred to new NBS laboratories in Corona, California. Here he was in charge of the technical development of the Petrel missile, and simulator studies of Petrel and other guided-missile systems. He was directly responsible for establishment at the new laboratories of one of the most complete simulator facilities in the U. S. In 1953 he was appointed Chief of the Missile Systems Division, Naval Ordnance Laboratory, when this laboratory was formed by transfer of the NBS Corona Laboratory to the Navy. He was in technical and administrative charge of all missiles research and development at the laboratory.

In 1954 he returned to NBS, Washington, D. C., where his present position is Assistant Chief of the Data Processing Systems Division. He serves as deputy to the Chief of the Division, as well as in direct charge of all activities in the field of analog computation, simulation and automatic control. He recently was responsible for the development of a special analog computer for predicting the distribution of radioactive fallout from a nuclear explosion, and is now active in developing means of simulating complex military systems using combined analog-digital techniques.

Dr. Skramstad is an Associate Fellow, Institute of Aeronautical Sciences; Senior Member, Institute of Radio Engineers; and a member of the American Physical Society, Philosophical Society of Washington, Phi Beta Kappa, and Sigma Xi.

The Data Processing Systems Division of the National Bureau of Standards receives two copies of *Instruments and Automation*, one kept in the Division library, and one circulated to professional staff members. Harold says, "We started using *I&A* actively when the Data Processing Systems Division was formed about 2½ years ago. It is regarded as an excellent source of information on activities and new developments in the instrumentation, automatic control, and computer fields."

Harold's off-job interests include camping, photography, hi-fi and boating. He has taken his wife, three sons, and a daughter across the U.S. three times, camping out all the way. Currently, he is working on an outboard runabout that he plans to trail behind his car to vacation spots on the Chesapeake Bay and elsewhere this summer.

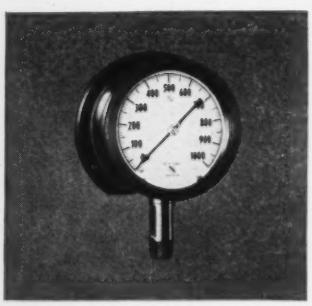


Why does the BOURDON TUBE in the ASHCROFT DURAGAUGE insure sustained accuracy?

FOR FAST SERVICE, get in touch with your Industrial Supply Distributor. He is fully acquainted with Ashcroft Duragauges and their proper selection for all kinds of applications.

8 TUBE MATERIALS permit selection of the *best metal* for particular service conditions. These materials include phosphor bronze, alloy steels, "K" Monel, stainless steels, and beryllium copper.

Every Bourdon tube used in the Ashcroft Duragauge is extra-wide – highly sensitive to slight pressure changes. Socket and tip joints are welded or brazed, then stress relieved after assembly, to assure maximum safety and uniform structure for highest corrosion resistance and strength. Each tube assembly is "whip tested" at pulsating pressures approximately 50% higher than its pressure rating to insure calibration stability.



The Ashcroft Duragauge is available with all-stainless-steel movement or stainless steel with nylon bearings and pinion gear. A choice of case designs and materials, dial sizes and pressure ranges readily satisfy the most exacting requirements. Whatever the working pressures or corrosive conditions of your operations, specify Ashcroft Duragauges and be sure of highest sustained accuracy and long service life.

1850 ASHCROFT U.S.A

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

ASHCROFT GAUGES

MAXWELL MANNING M&M MOORE TRADE MARK

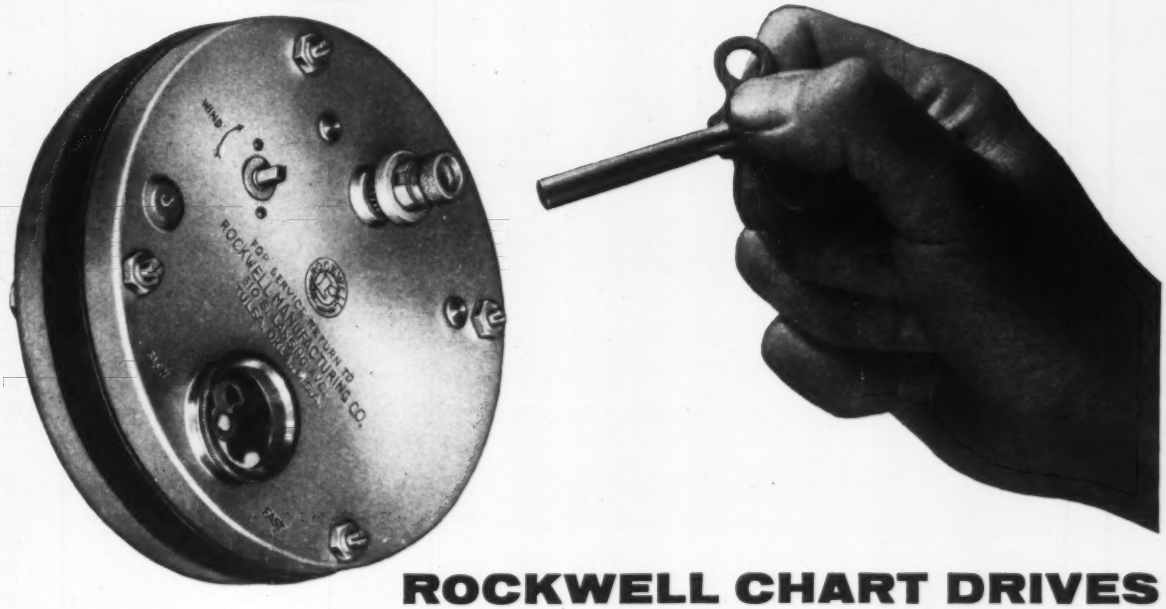
A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES *Muskegon, Mich.*

For more information circle **52** on inquiry card

How you benefit from

New Fast Winding



ROCKWELL CHART DRIVES

SAVE TIME Whether you wind by key or crank, you will find that *new* fast winding Rockwell Chart Drives will reduce the time and effort required to service your recording instruments. Fewer turns, easier turns result from an entirely new gearing design.

REDUCE MAINTENANCE A stronger, double bushed winding pinion now minimizes one of the principal causes for chart drive failure. Powdered metal bushings throughout the new winding mechanism eliminate all need for lubrication.

FACTORY MODERNIZATION AND REBUILDING SERVICE All old model Rockwell Chart Drives returned to the factory will be modernized with the latest advancements including the new fast wind mechanism *at no additional cost* beyond the regular nominal service charge. Now is the time to upgrade your instrumentation. Ship us your old Rockwell Chart Drives for thorough rebuilding and modernization.

ROCKWELL MANUFACTURING COMPANY

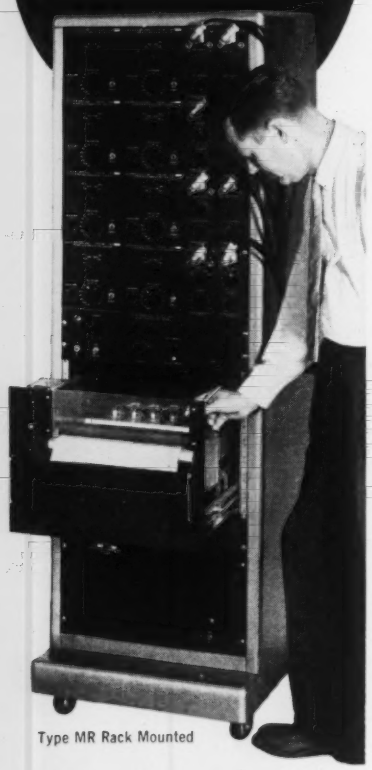
INSTRUMENT DIVISION BOX 2396, TULSA, OKLA.

Atlanta Boston Charlotte Chicago Dallas Denver Houston Los Angeles Midland, Texas New Orleans New York N. Kansas City Philadelphia Pittsburgh San Francisco Seattle Shreveport Tulsa

In Canada: Rockwell Manufacturing Co. of Canada, Ltd., Toronto, Ont.

For more information circle **53** on inquiry card.

OFFNER
DYNOGRAPH



Type MR Rack Mounted

DIRECT WRITING OSCILLOGRAPH

unequalled for versatility and performance!

. . . rectilinear recording
. . . curvilinear recording
. . . heat sensitive recording
. . . electric recording
. . . ink recording
. . . 15/μv/mm d-c sensitivity
. . . zero drift

IN A SINGLE RECORDER!

Write for 12 page, 2 color catalog—gives details and specifications.

OFFNER ELECTRONICS

5326 N. KEDZIE AVE. • CHICAGO 25, ILL.

For more information circle **54** on inquiry card.

Panhandle Pete

The Instrument Salesman and the 1040

Blue Monday, April 1, 1957. Rain and Fog, got up late, struggled into town through the traffic jams; had flat tire in Liberty Tubes; got to office parking lot—found it full-up; left car in alley.

Got trapped in revolving door for half an hour when lock accidentally tripped—why do people stand around and stare so at others in trouble?—found elevator operators out on strike so had to walk up twenty six floors to office. Boss not expected in—too old to climb twenty six floors (Has weak heart too. Wonder when he is going to drop dead so I can take over? Wish we had an employee suggestion-box plan here!) Sat around drinking cold coffee—power failure on canteen—but as things were real pokey around the office, decided to go home.

Rode down in elevator (by some quirk of psychology the union allows operators to bring you down); found car in alley with all the fenders smashed in—fire truck went through; drove home and found wife absent, mixed a drink and went to bed with Post Gazette.

Ah me, just dropped off to sleep when the wife stormed in, raised cain about the car, raised the windows and pulled the covers off me and the bed and said something about "If you are going to stay home to-day you might as well do something useful so start taking down the Christmas decorations and the tree!" Oh my gosh! And I had the prettiest set of lights on the tree this year and the cleverest Santa Claus, Snow White, and Seven Dwarfs on the roof-top in the neighborhood. "Do I have to take down my electric train and put it away too?" I asked the wife. I can't understand her—the tree shed all its needles long ago; what's her hurry about taking it down? Another thing I never noticed before; when the wife walks, the view from the rear looks just like a couple of bull dogs fighting under a blanket. She's gonna have to go on a diet!

Went and borrowed ladder from neighbor. Got up on roof and just got a good start on taking off Snow White's dress when the wife hollered up, "You're wanted on the telephone." "Well find out who it is. Can't you see I'm up here?" I'll never understand my wife's thinking. "What?" Its "Horse' McNulty?" Oh, oh, that's one guy I don't want to talk to. "Tell him I'm not here. Tell him I'm out of town. Tell him I just left to hunt snakes in Central America. Tell him . . . . . what? OK, OK, I'll come down; don't want him coming out here." Whoops, foot slipped on wet roof and down come Dwarfs and old red-nosed Rudolph all in a heap with me. Some days it doesn't pay to get up.

"Hello, 'Horse', old pal, old boy, what's on your mind?" I started to say . . . "What do you mean soft soap? You know darned well you

need that encoder your wife bought last December. Who's an old goat? Blackmail? Wait a minute, you can't cancel the order, it is already shipped; I don't care who you know at the factory . . . there's a new rule . . . well you can go there yourself and be among friends! You hope I choke when I pay my income tax to-day? Goodbye!"

Hey old lady. I have to send in my quarterly income tax to-day. Come help. Where is the tax form, pencils, paper, records, expense account. . . . Holy smokes am I glad "Horse" called today. Let's see, everything is pretty well up to date . . . is there any commission due before the 15th? Hmmmmm. Great jumping jehosaphat! "Horse's" order will be in and I'll get paid for it. How much will that be? $414,159.13 plus $830.00 for freight . . . $9,449.67 state tax . . . plus 10% for depreciation . . . gee! $356,882.68 so far. 'Horse'll' never have that kind of money . . . finance charge of . . . oh my . . . $547,220.11 total price to "Horse". Fifty percent of this is my commission which comes to $273,610.005 . . . $273,610.-005! Judas priest! I wish the company wasn't so generous with their money. I can't stand this prosperity. This sale jumps me into the 80% bracket. What about my company pension plan; my insurance, my deductions? "Hey old lady, how much money is in the checking account? Only $45.06?" My gosh, what'll I do now? Get a loan? Nope, already owe everybody in town—too much prosperity. "Do you have to pay the tax, dear, I recall reading about someone who owes the government over two million dollars. ." asks the wife. How silly can she get?

There's only one thing left to do between me and complete ruin—get "Horse" on the 'phone and stop the order. By what subtle chicanery can I persuade him to cancel his order? " 'Hello, 'Horse', old boy, old pal! Been thinking your problem over. Since we are such good friends I took the bull by the horns, called the old man up at the factory and told him to stop the sale and get the encoder returned; rules are rules but what the heck, friends are thicker than thieves . . . huh? What do you mean you'll sue me? You mean you want the encoder now because your lawyer showed you how to deduct it from *your* tax and you are going to save wads of money? Where am I going . . .? Atlanta?" Oh my gosh! How do I get involved in these situations? Hey old lady! Pack my bags; I'm going to Central America after all.

Panhandle Pete

DEMAND TOP PERFORMANCE !

...specify

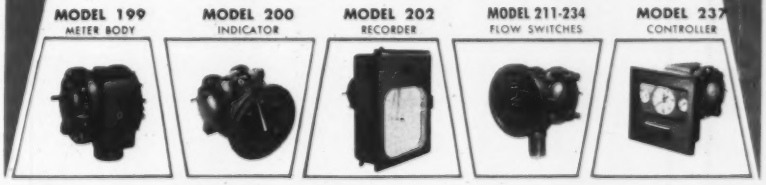
BARTON 214

DIFFERENTIAL PRESSURE TRANSMITTER

WHEN MODERNIZING YOUR INSTRUMENTATION

The Model 214 D.P. TRANSMITTER incorporates the newest features for accurate, dependable performance in the precise measurement of flow, liquid level and/or differential pressure. Transmits with high speed and sensitivity, and low air consumption, yet is very stable, unaffected by over-range, and is virtually immune to vibration, temperature and pulsation. Ranges from 0-20" W.C. to 0-400" W.C. and S.W.P. to 6000 psig. For further information request Bulletin 214-1 or contact Barton Sales Engineers in principal cities.

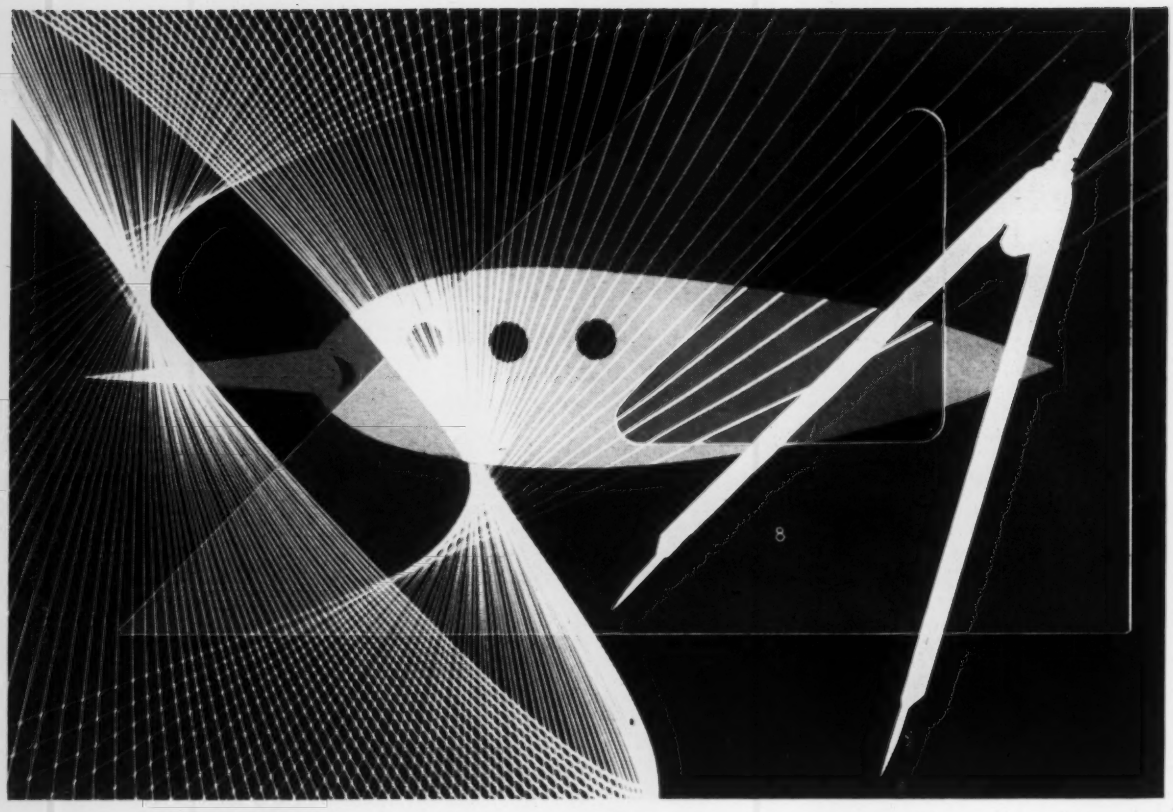
for the very BEST IN FLOW BARTON



BARTON INSTRUMENT CORPORATION

580 MONTEREY PASS ROAD, MONTEREY PARK, CALIFORNIA

For more information circle 55 on inquiry card.



Creative Engineers:

Work where the breakthroughs are being made in every major field of Electro-Mechanics

As a creative engineer, you belong at the front-line of your field . . . where tomorrow's scientific battles are being won . . . where you can help win them.

For more than a decade, AUTONETICS has been at the forefront of electro-mechanical technology . . . building up the unique stockpile of experience and developing the advanced techniques and tools that can make your professional victories possible at AUTONETICS today.

Just a few specific results of AUTONETICS' pioneering are: the MG-4 Fire Control System for NATO's F-86K Sabre Jet; Flight Control elements for the F-100 Super Sabre; *Numill*, a new magnetic-tape controlled machine-tool system capable of performing complex milling and drilling operations automatically; *Recomp I*, a new portable, high-speed, completely transistorized digital computer; and inertial guidance systems for both airplanes and missiles.

Today, our programs are gathering speed, broadening scope. New engineering methods have been developed to cut lead time. System and component evaluation is being accelerated with automatic checkout equipment. Packaging is being designed and systems micro-minaturized to fit the cramped confines of sleek missiles and jets.

YOUR OPPORTUNITY EXISTS AT EVERY LEVEL of creative engineering from Preliminary to Performance Test—because Autonetics is one of the few companies in the world that can design and quantity-produce complete automatic control systems for both the military and industry.

LET US KNOW what kind of creative engineering interests you (please include highlights of your education and experience). Write today to: Mr. A. N. Benning, Administrative and Professional Personnel, Dept. 358-IA-5, AUTONETICS, 9150 E. Imperial Highway, Downey, California.

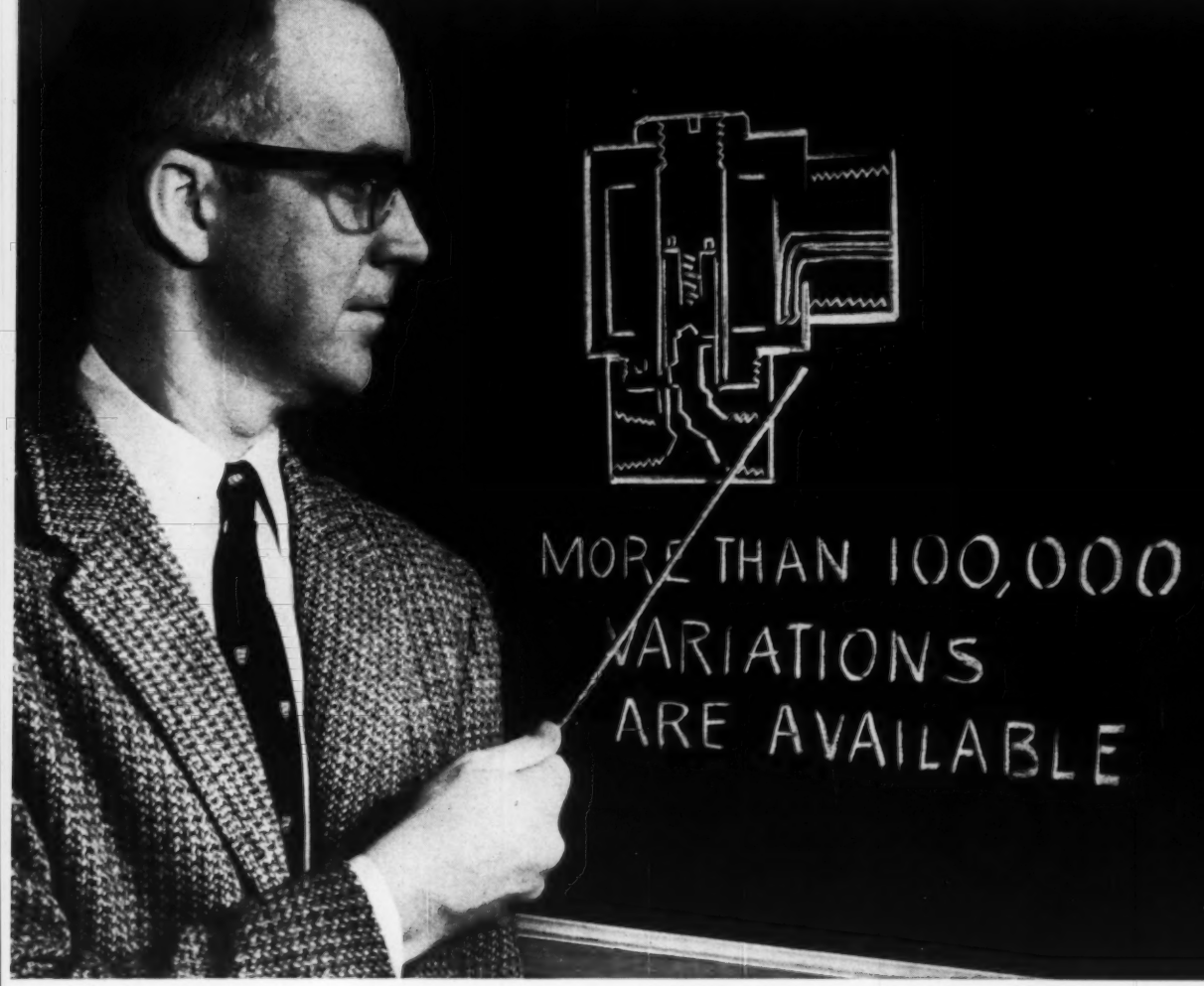
Assistant Chief Engineer Norman F. Parker joined Autonetics in 1948 after receiving his DSc from the Carnegie Institute of Technology. Dr. Parker has been recognized nationally for his work in Inertial Navigation, and was chosen recently to present a paper on that subject at a NATO conference in Italy.

Jack Wittkopf was Associate Professor of Electrical Engineering at Oregon State for 6 years before he joined Autonetics in 1951. Now Group Leader in computers and electronics, Jack lives with his wife and four children in Autonetic's home town of Downey, California, where his spare time activities include photography and ham radio.

Autonetics
A Division of North American Aviation, Inc.

AUTOMATIC CONTROLS MAN HAS NEVER BUILT BEFORE

Circle 56 on inquiry card.



You can get the *custom designs* you want from a basic Skinner Solenoid Valve

In the small-size solenoid valve field, Skinner offers a wider variety of variations and optional features than any other manufacturer. Take, for example, the standard V5 model shown above in cutaway form. Its design is so flexible that the valve can be supplied for applications which would otherwise call for "specials." So, if you have a solenoid valve problem, we urge you to talk to a Skinner representative. Tell him your requirements in regard to port sizes and locations, voltages, pressures, temperature conditions, flow adjustments and mountings. Let him show you how easily he can select the valve you need.

When you specify Skinner, you get custom design plus outstanding service performance. Continuous testing in our labs and actual results in the field prove that Skinner valves have exceptional leakproof life. For complete information on Skinner's line of 2-, 3- and 4-way valves, write us or contact a Skinner representative. Write Dept. 415.

Skinner Solenoid Valves are distributed nationally

See us at the Design Engineering Show, Booth 708.

SKINNER ELECTRIC VALVES

THE CREST OF QUALITY

SKINNER ELECTRIC VALVE DIVISION

NEW BRITAIN CONNECTICUT

105 EDGEWOOD AVENUE

SALES MANAGERS: You route this memo—

to your ad department and agency—reminding them to plan now to advertise in the 1958 I&A Handbook & Buyers' Guide

Industry's only instrument-control equipment buying directory, the Guide offers you . . .

- Entree to 23,000 buyers of instrument and automatic control equipment.
- A directory listing equipment, names and addresses of 3,000 manufacturers.
- Twenty-two years experience selling to OEM and end users.
- Year 'round contact with industry's big buyers.

Reserve your ad space now. Forms close August 15-31—write:

INSTRUMENTS PUBLISHING CO., INC.
845 Ridge Ave., Pittsburgh 12, Pa., FAirfax 1-0161

Consolidated now offers a complete line of High-Performance Galvanometers with higher sensitivities and higher frequencies than ever before available in single instruments. Their performance approximately *doubles* the former maximum frequency range for direct recording, and in some instances, sensitivity has been *quadrupled.* CEC's High-Performance Galvanometers open a completely new field of applications.

FOURTEEN TYPES

CEC's High-Performance Galvanometers cover a flat-frequency-response range of 0 to 5000 cycles with sensitivities as high as 1.6 μa/in. Each type is designed to meet one of the commonly used strain-gage-bridge resistances of 120, 180, or 350 ohms.

For complete data, contact your nearby CEC field office, or write for Bulletin CEC 1528-X6.

Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena, California

OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

For more information circle **57** on inquiry card.

NEW CONTROLLER LINE ADAPTS 576 WAYS

Fenwal Announces Low-Cost Temperature Indicating Controllers

ASHLAND, MASS. — Fenwal Inc., has announced here that tailor-made, accurate, low-cost temperature indicating controllers are now available from stock.

Tailor-mades from stock are made possible by the development of the new Fenwal Series 541 line. The Series 541 is a standardized line of matched temperature indicating controller parts which can be combined easily in 576 ways.

From these possible combinations come perfect solutions to countless temperature control problems. A prospective user lists the characteristics of the ideal temperature indicating controller for his particular operation, and Fenwal assembles an instrument with those characteristics from parts in stock.

No matter what combination is chosen, the result is a rugged, accurate, compact and easily maintained unit in a shock-proof, splash-proof, dust-proof housing. The housing is available in colors to match any equipment in which it may be installed.

Installation and calibration are so simple that instrument technicians and laboratory procedures are unnecessary. And, after installation, all normal temperature adjustments are external.

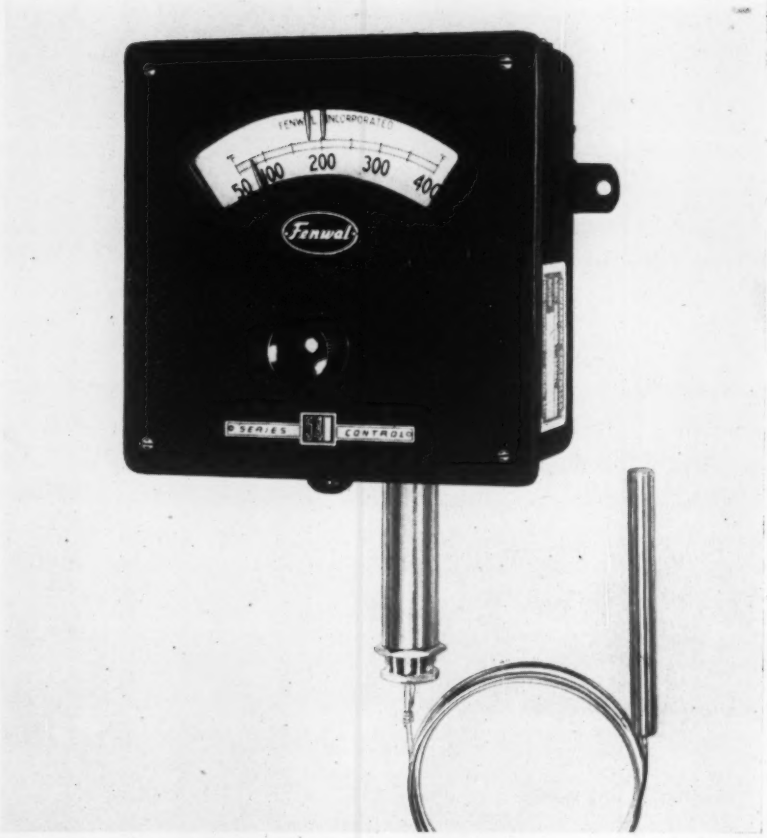
No matter what combination is chosen, the resulting instrument is accurate to within one per cent of scale. The accuracy is long lasting, with few moving parts and no internal gears. Simplicity of design brings the wear factor close to zero.

Series 541 offers single or double circuit control. There is a choice of four different long-life snap switches, with ratings up to 20 amps, 250 volts, A.C. These switches, singly or in combination, can provide a wide variety of operating characteristics.

Three stainless steel bulb types are available at no increase in price to meet space or process requirements. Capillaries and bulbs are corrosion-proof. Capillaries are swivel-mounted to protect them from breakage.

There is a choice of three temperature ranges: −150° to 200°F, 50° to 400°F, or 50° to 700°F, or their centigrade equivalents. Special ranges are available on request.

The control mechanism may be subjected to temperatures up to 150°F, and is ambient compensated from 50° to 150°F.



One of Fenwal's new Series 541, bulb-and-capillary controllers. Photo shows dual circuit model which has two snap switches, each with a setpoint indicator, that actuate two separate circuits at the pre-set temperatures.

Write to Fenwal Incorporated, 365 Pleasant Street, Ashland, Mass. Describe the tailor-made temperature indicating controller that would fit your operation perfectly. Chances are excellent that the tailor-made can be yours — at savings never before possible.

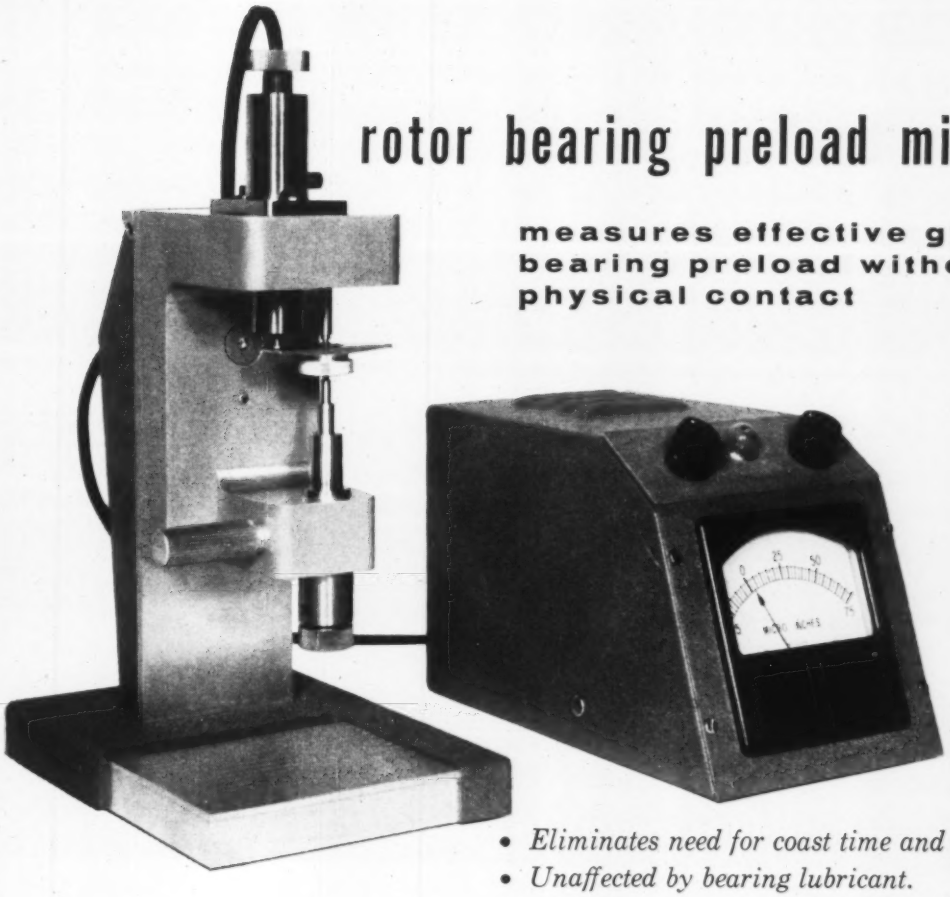
Fenwal

CONTROLS TEMPERATURE ... *PRECISELY*

For more information circle **58** on inquiry card.

rotor bearing preload micrometer

measures effective gyro rotor bearing preload without physical contact



- *Eliminates need for coast time and acceleration tests.*
- *Unaffected by bearing lubricant.*
- *Amazingly compact and portable.*
- *Rugged construction for production line service.*
- *Sensitivities as high as .000005 inch per division.*

THE DECKER MODEL 104-1 ROTOR BEARING MICROMETER provides a positive and accurate means of measuring effective bearing preload . . . a prime factor in rotor performance.

Accurately measuring axial movements to known standards, the micrometer simplifies one of the most difficult jobs in rotor assembly . . . . obtaining prescribed bearing preload. Benefits gained include a reduction in rotor assembly time...less need for skilled labor . . . no chance of bearing damage during run-in . . . and fewer rejections due to improper preload.

Simple adapter assemblies quickly convert the unit for handling many types of rotors, ranging in size from less than ½" diameter to 3¼" diameter.

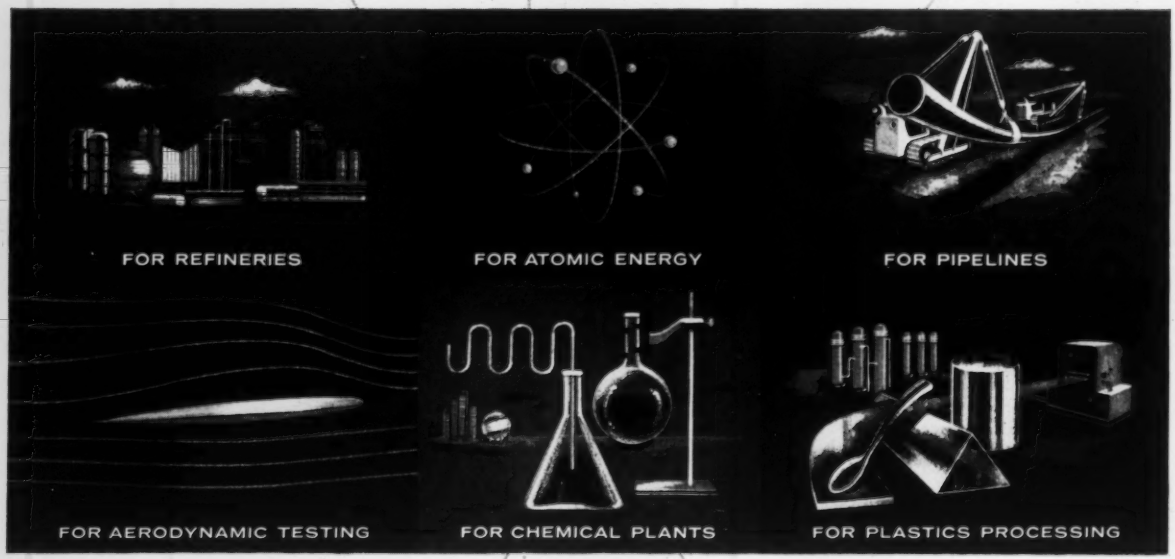
Complete information on this unique new instrument is in Data Sheet 104-1, available upon request to the Technical Literature Section.

decker AVIATION CORPORATION

1361 Frankford Ave., Philadelphia 25, Pa., PHONE GArfield 5-2300

For more information circle **59** on inquiry card.

GO AUTRONIC



Without adequate process control systems your new plant can quickly slide from competitive . . . to obsolescent . . . to *obsolete*.

Modern, high efficiency plants keep obsolescence at bay the all-electronic way—with Swartwout Autronic Controls.

You'll go all-electronic eventually —*Go Autronic now with Swartwout, pioneer and leader in electronic process controls.*

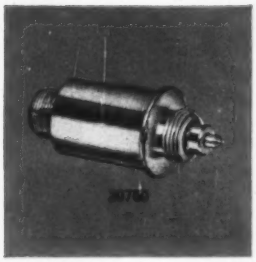
AA-4070

Swartwout

AUTRONIC® CONTROL SYSTEMS

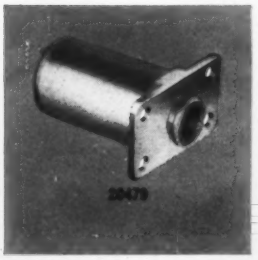
The Swartwout Company
18511 Euclid Avenue • Cleveland 12, Ohio

For more information circle **60** on inquiry card.



true hermetically sealed solenoids

Just like a sealed vacuum tube! True hermetic sealing around a solenoid . . . glass seal terminals, lugs, and connectors. All welded and brazed construction. Completely plated after assembly. Exceed most requirements of military specification MIL-S-4040 (USAF). Priced at approximately the same level as conventional types.



high-temperature solenoids

These modern new solenoids give you a reasonable life expectancy at temperatures as high as 350° C. A by-product of hermetic sealing. Class H insulation combined with inert gas filling add those necessary extra few degrees needed in your temperature limits . . . make these solenoids exceptional high-quality, high-temperature units.

~~D C~~ solenoids

. . . and those unusual specialties you look for!

Having trouble finding solenoid specialties? Here at Cannon, we'd like to help you. Standard production now includes multiple-strip solenoids for keyboard operation, locking types requiring no holding current, and miniatures and sub-miniatures ½" diameter. In addition, our expanded solenoid engineering department is ready to serve you at any time.

CANNON PLUGS

CANNON ELECTRIC CO., 3209 Humboldt St., Los Angeles 31, Calif.
Please refer to Dept. 419
Factories in Los Angeles; East Haven; Toronto, Canada; London, England.
Representatives and distributors in all principal cities

Please ask for latest SR-S releases and/or Solenoid Bulletin.

For more information circle **61** on inquiry card.

It's the **Original Equipment* idea . . . which simply means that, when you're figuring on electrical or mechanical counters in any new product, it pays to *design them in, when you begin.*

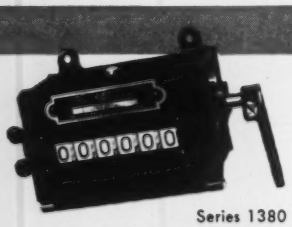
For then Veeder-Root quite likely can save you time and money by adapting or modifying a *standard* counter to your needs, instead of a special which you might specify on your own. This solves the counter problem . . . and saves you time in engineering, purchasing and assembly.

What's more, you give your product new sales-advantages: Direct-reading digits, instead of hard-to-read dials and verniers . . . instant remote indication if needed . . . up-to-the-minute performance records that serve as a basis for production-*Count*rol, and as proof of your performance guarantee. So don't let counters take a back seat in your new-product plans. *Design them in, when you begin* . . . it pays in many ways. Do you have the newest Veeder-Root Catalog? Write

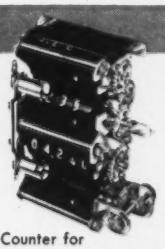
Series 1205
Reset Magnetic Counter

Everyone Can Count on Veeder-Root INCORPORATED

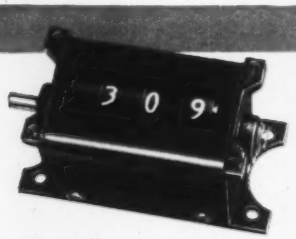
Hartford, Conn. • Greenville, S. C. • Chicago • New York
Los Angeles • San Francisco • Montreal
Offices and Agents in Principal Cities



Series 1380
Box-Type Counter (Ratchet, Revolution, or Geared)



4-bank Counter for
Radio Transmission Equipment

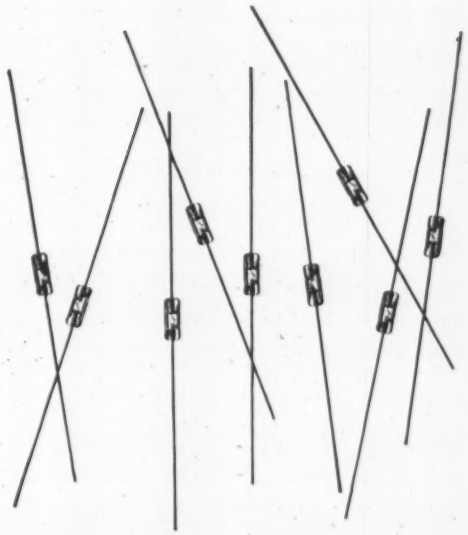


360-degree Bearing Counter

For more information circle **62** on inquiry card.

HIGH CONDUCTANCE SILICON DIODES

Now, at Hughes, two new series



First, a high conductance series designed for operation up to 150°C and featuring forward conductance of at least 200mA at 1 volt, together with excellent reverse characteristics. Like all other Hughes diodes, these are packaged in our famous glass body for complete protection from contamination and moisture penetration. And like all other Hughes diodes, they conform to published specifications under a variety of operating conditions. Here, then, are specifications for representative types in the series.

	Max. DC Inverse Operating Voltage (volts)	Maximum Average Forward Current (mA) @25°C	@150°C	Maximum Forward Voltage @200mA @25°C (volts)	Inverse Current At Specified DC Test Voltage (μa) 25°C	150°C	Test Voltages (volts)
HD-6764	70	200	50	1.0	0.025	5	60
HD-6766	130	200	50	1.0	0.025	5	125
HD-6768	180	200	50	1.0	0.025	5	175
HD-6771	225	200	50	1.0	0.05	25	225
HD-6773	300	200	50	1.0	0.1	25	300
HD-6775	380	200	50	1.0	0.1	25	380

Second, a related high conductance series in the Hughes glass package with somewhat different characteristics.

	Comparable Competitive Types *	Max. DC Inverse Operating Voltage (volts)	Maximum Average Forward Current (mA) @25°C	@150°C	Maximum Forward Voltage @100mA @25°C (volts)	Inverse Current At Specified DC Test Voltage (μa.) 25°C	150°C	Test Voltages (Volts)
HD-6132	1N482B	36	200	50	1.0	0.025	5	30
HD-6133	1N483B	70	200	50	1.0	0.025	5	60
HD-6134	1N484B	130	200	50	1.0	0.025	5	125
HD-6135	1N485B	180	200	50	1.0	0.025	5	175
HD-6136	1N486A	225	200	50	1.0	0.05	25	225

* Currently these competitive types are not registered with RETMA; hence their specifications are subject to change. When they are registered, diodes now designated as HD types will be supplied as 1N types according to the registered specifications.

For details, please write: SEMICONDUCTOR DIVISION • HUGHES PRODUCTS
International Airport Station, Los Angeles 45, California

HUGHES PRODUCTS

© 1957, HUGHES AIRCRAFT COMPANY

HUGHES
SEMICONDUCTORS

For more information circle **63** on inquiry card.

Simplify control problems...

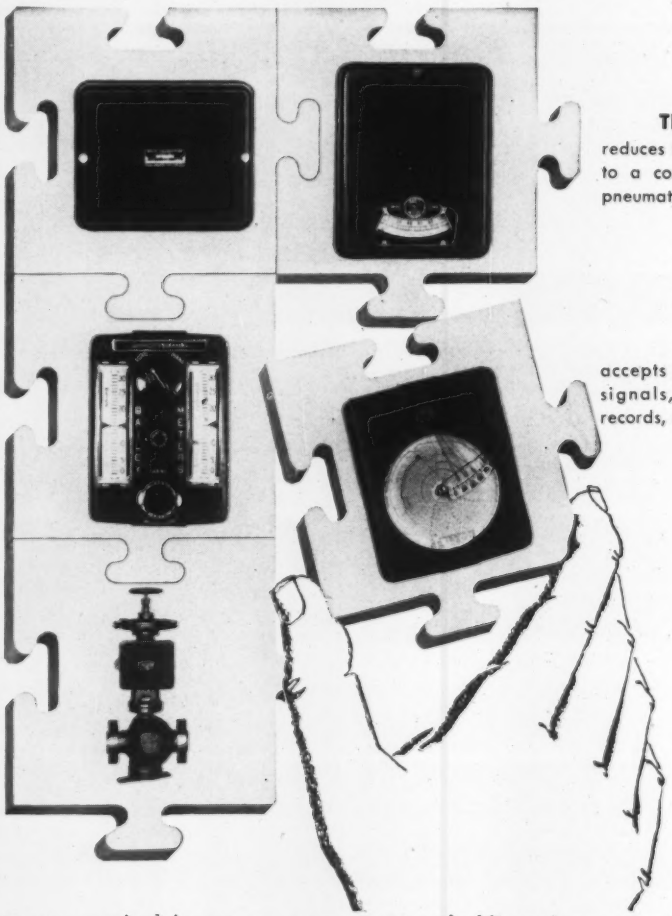
with the Bailey Building Block Method

Control problems are greatly simplified when you attack them using the Bailey Building Block Method. In a nutshell, the method consists of using standard components that fit together like building blocks. Virtually any control requirement can be handled by selecting standard components. Here are the parts you use and the functions they perform.

CONTROL RELAY
takes signals from the transmitter and computes corrective action in terms of pneumatic signals.

SELECTOR STATION
gives operator choice of hand or automatic control including set-point or bias adjustments.

POWER UNIT
is the "muscle" of the system. It performs whatever precise mechanical action is necessary to achieve control.



TRANSMITTER
reduces the measured variable to a common denominator, a pneumatic or electric signal.

RECEIVER
accepts pneumatic or electric signals, indicates and/or records, measurements.

Not all these components are required in every control system. You buy only what *your* system needs. When you change processes or add more automatic control, you can add additional standard components. Sometimes you may want to build a whole new system, re-using some of the existing components and adding other new ones. Spare parts inventory and maintenance training are reduced.

Hear the complete story of the Bailey Building Block System. Find how it can solve your control problems. See your Bailey Engineer or write for more information. G44-1

BAILEY METER COMPANY
1041 IVANHOE ROAD, CLEVELAND 10, OHIO
In Canada—Bailey Meter Company Limited, Montreal

BAILEY BUILDING BLOCK METHOD

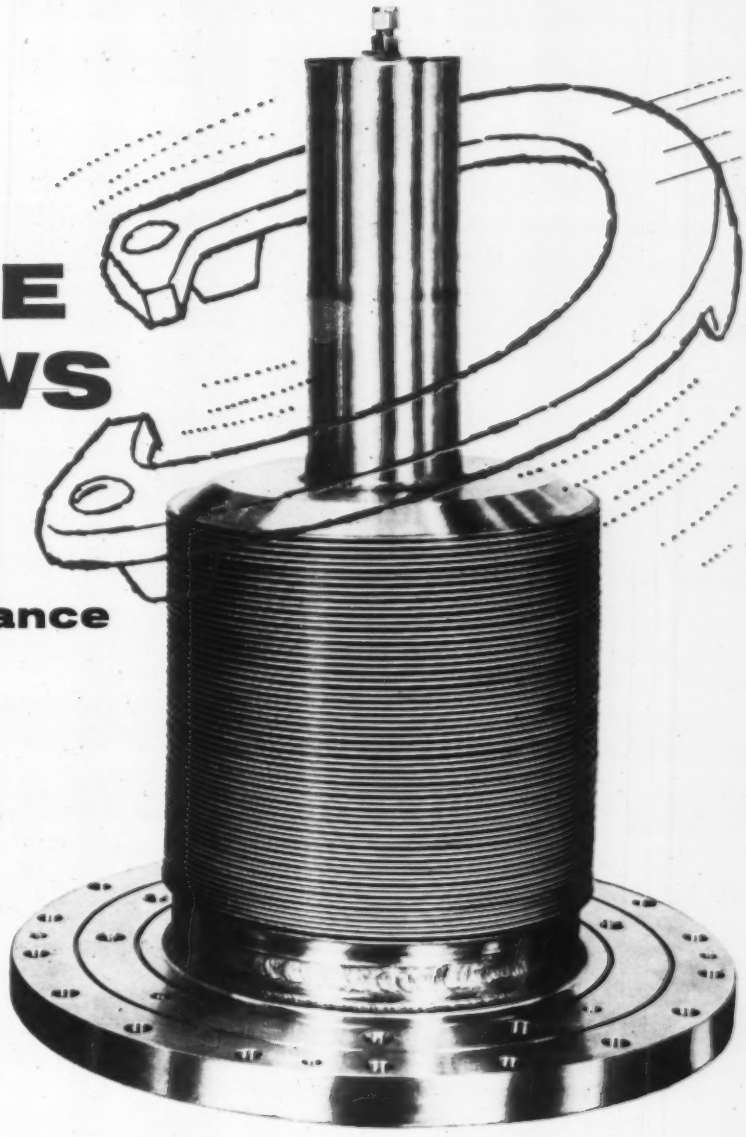
RESULTS IN: FLEXIBILITY, SIMPLICITY, ECONOMY

BAILEY METERS

For more information circle 64 on inquiry card.

BREEZE BELLOWS WIN

the tough game of high performance

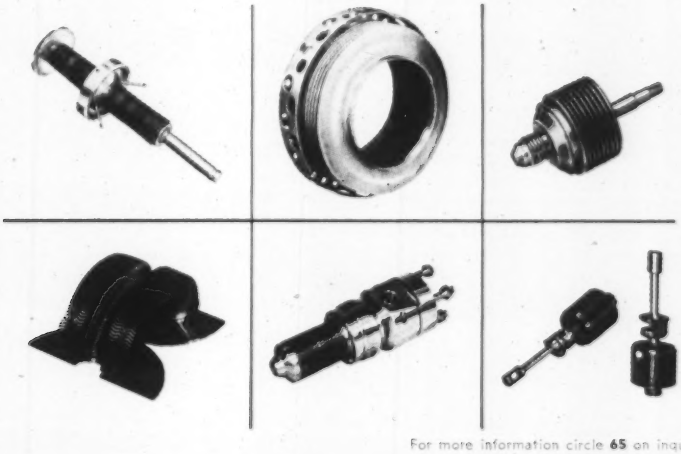


Breeze bellows engineers work in that challenging area where ready-made designs won't do the job. Every project is a custom project, engineered specifically for each problem application.

We have a wealth of experience with all weldable alloys such as Inconel X, titanium, Ni-Span, Hastelloys, Stainless 300 and 400 steels.

We are solving critical problems in instrumentation, fuel regulation, pressure switches and expansion joints, hot air ducting, pressure surge tanks, packless valves, expansion and vibration joints, oscillating and rotating shaft seals, atomic and nuclear reactors.

Breeze invites your inquiries on bellows jobs *beyond the routine* . . . for the most exacting requirements.



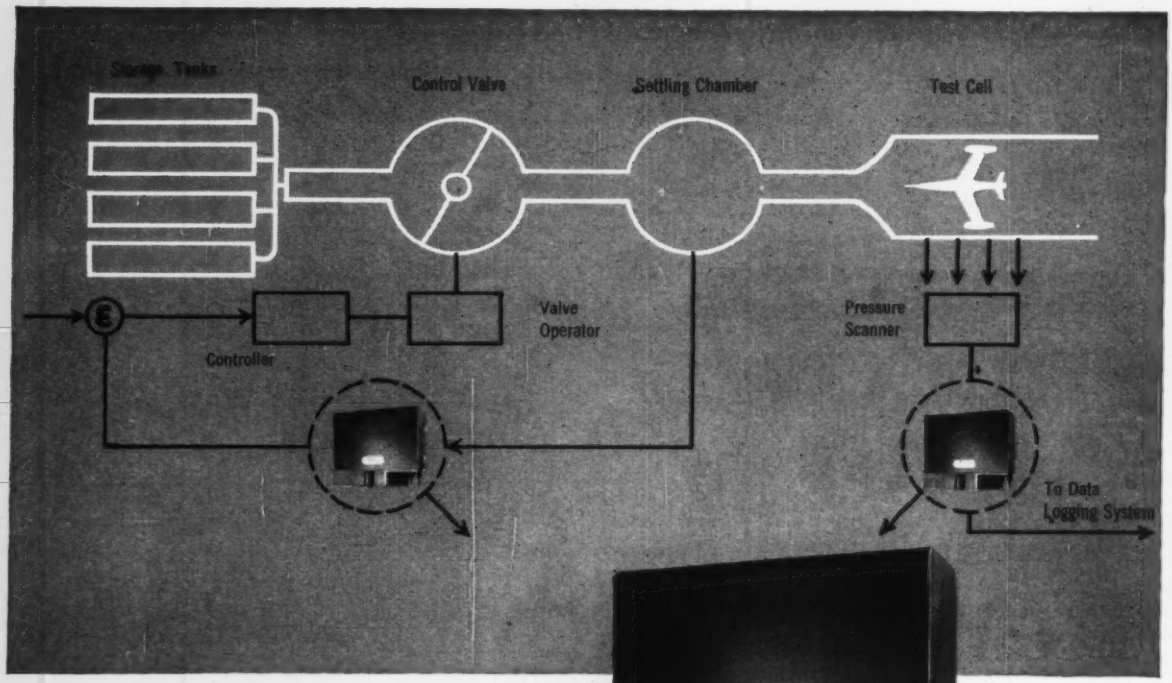
BREEZE

CORPORATIONS, INC.

700 Liberty Avenue, Union, N. J.

BREEZE MARK

For more information circle **65** on inquiry card.



HAGAN POWRAMP MODEL "A-2"

PRESSURE TRANSDUCER

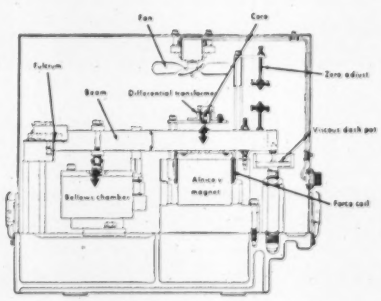
ACCURACY, 0.1% OF FULL RANGE — RESPONSE, 40 CPS — SENSITIVITY, .01% OF FULL RANGE

Up to ten times more accurate than conventional "displacement type" transducers, the Hagan PowrAmp Model A-2, with its companion amplifier, produces a dc output signal directly proportional to the input pressure. Available full scale ranges include absolute and differential ranges from 6 to 240 psi and gauge pressure ranges from 6 to 2000 psi.

The Model A-2 is a fast feed-back, force-balance pressure pickup, with very low drift characteristics. The high speed and extreme accuracy of the Model A-2 make it ideal for use in electronic control systems where precise measurement is critical, or in single or multiple pressure readout systems.

Hagan PowrAmp transducers for most key variables, electro-hydraulic servo valves and electronic control computers are available as components or as units in engineered systems. Bulletin MSP-133, which describes the full line of Hagan PowrAmp components will be sent on request.

For additional information on the A-2 Transducer write for Specification Sheet PE 5000



SPECIFICATIONS OF MODEL A
(with companion amplifier)

Output	0-25 Volts or 3-28 Volts dc
Output Impedance	Approximately 100 ohms
Resolution Sensitivity	.01% Full Scale
Linearity	.05% Full Scale
Overall Accuracy	0.1% Full Scale
Frequency Response	Flat to 40 CPS Phase Shift at 16 CPS—5° Lagging

HAGAN CHEMICALS & CONTROLS, INC.

HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
DIVISIONS: CALGON COMPANY • HALL LABORATORIES

For more information circle **66** on inquiry card.

how big can a small valve be?

Take this Hoke needle valve for instance...it looks pretty small on the front panel of Perkin-Elmer's new vapor fractometer, but it looks *big* in the eyes of the man who's buying or making equipment like this. Just a handful of brass? That's so, but carefully fashioned to control up to 3000 psi with no strain! It's added evidence of careful engineering.

Whether you're the man who makes high quality test equipment or the man who uses it, we'd like to prove to you how *big* Hoke valves can be. There are valves in the Hoke line for hydraulic and pneumatic equipment; for instrument panel or test stand use; for pilot plants . . . Forged needle valves (like the one shown), bar stock valves, packless valves and toggle valves. May we send you a catalog?

See us at
DESIGN ENG. SHOW
N.Y. Coliseum, May 20-23

HOKE, INCORPORATED, FLUID SPECIALISTS, 231 S. DEAN ST., ENGLEWOOD, N. J.

HOKE

For more information circle 67 on inquiry card.

MEASURE MICROVOLTS *without pre-amplification!*

with the New Du Mont type 403

$580.

FEATURING

AMPLIFIERS: Direct coupled amplifiers with single-ended or balanced input.

EXTREME SENSITIVITY: 5 millivolt to 500 volts full scale, continuously variable. Additional sensitivity for short term measurements, with resolution down to 20 microvolts.

FREQUENCY RANGE: DC to 300 KC.

Y AMPLIFIER CALIBRATION: 5%.

SWEEPS: 19 calibrated linear sweeps, 0.5 sec/cm to 0.5 usec/cm. Calibrating accuracy, 5%.

EXPANDED SWEEP: Any 10 cm portion of 50 cm sweep may be expanded 4 times and positioned on screen.

Price **$580.00**
Slightly higher in 50 cycle areas

TYPE 403R Rack mounted version, electrically identical to Type 403 $595.00

Complete Details On Request...

The Type 403 is the most sensitive oscilloscope commercially available. It permits direct measurements from low output transducers such as strain gages, pressure pickups, accelerometers, and others that normally require preamplifiers.

When used as a direct reading voltmeter, the Type 403 offers stability of better than 1 millivolt per hour for all ranges from 500 volts all the way down to 5 millivolts full scale. A super sensitive range is available of 1 millivolt full scale (100 microvolts per scale division) for short term measurements.

This outstanding performance is wrapped in the nicest package in the industry. The 403 features "human engineering" resulting in easier operation, complete accessibility and unsurpassed reliability backed by a 5-year guarantee.

ANOTHER OF THE 400 SERIES

DU MONT

TECHNICAL SALES DEPARTMENT,
Allen B. Du Mont Laboratories, Inc., Clifton, N. J.

For more information circle **68** on inquiry card.

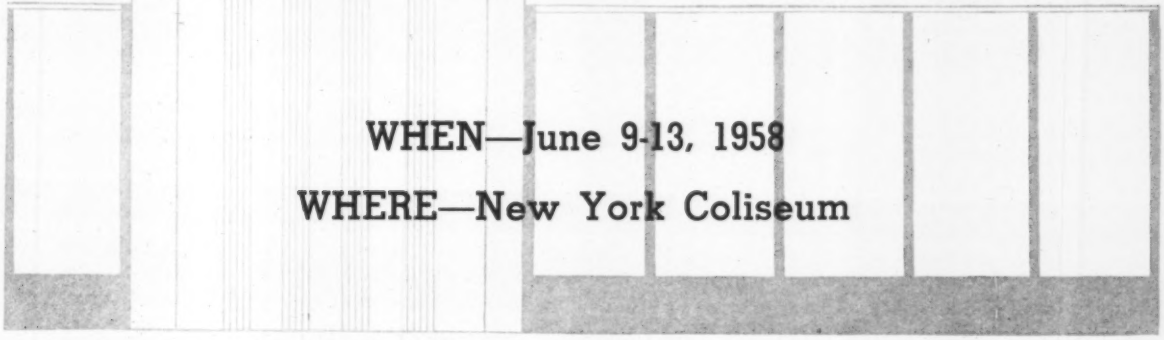
ATTENTION!

Sales Managers —

Exhibit space at the 4th INTERNATIONAL AUTOMATION EXPOSITION should sell-out in a hurry.

Plan now to budget time and money for 1958's biggest automation event.

Automation Congress, Conferences, and Clinics, associated with the Show, guarantee intensified local and overseas interest in this event.



WHEN—June 9-13, 1958

WHERE—New York Coliseum

For details, floor plans, etc., write

Fourth International Automation Exposition
c/o Richard Rimbach Associates, Management
845 Ridge Avenue, Pittsburgh, 12, Penna., FAirfax 19831

INSTRUMENTS and AUTOMATION

AUTOMATION: The use of devices—mechanical, pneumatic, hydraulic, electrical and electronic—for making automatic decisions and efforts.—*M. H. Aronson*, Editor

Editorial

Education—A Multi-Level Problem

THERE can be no subject of greater importance than education—but much of the common discussion and generalization on the subject ignores the fact that education comprises three levels—elementary, secondary, and university—each of which has unique problems. Although there is mutual dependence and interaction so that advancement or regression at any one level affects the others, the problems of "education" are quite different in each of these three basic levels.

For example, *the most serious shortage of classrooms and teachers is at the elementary level.* Just as the emotional character of the adult is formed between the ages of 1 and 5, the adaptability of the student to education is formed in the grade school, between the ages of 5 and 13. If the elementary-school student does not learn to read with pleasure, if he does not learn arithmetic without developing a neurosis against numbers, little hope exists for satisfactory secondary or college education in technology. At the elementary level, therefore, the student must not only be taught but phychologically conditioned to education. This requires small classes and good teachers—*more so at the elementay school level than at any other.* And it is at the elementary level that the problem of classroom and teacher shortage is most severe!

Inasmuch as the effect of improper early conditioning to education becomes noticeable only eight to ten years later, and inasmuch as later solution of essentially psychological problems induced a decade earlier is almost impossible, it is little wonder that many schemes proposed to aid education produce only failure, surprise, futility and consternation.

This national problem of classroom and teacher shortage at the elementary level demands a national solution—federal aid.

The basic argument against federal aid to education—that federal control leads to thought control—applies less at the elementary level than at any other. The student is being taught reading, writing and arithmetic. Even if our grade schools were full of teacher-propagandists, and even if the federal government never helps any group without propagandizing it and destroying its character (attention farmers, the oil industry, the aircraft industry, and all industries with accelerated tax amortization), it would still be safe to deliver a few of the billions raised by our income tax into the hands of local-school-district superintendents so that more grade-school classes can be built and more teachers hired. (This is a personal matter for every citizen reading this comment. Your comments—pro and con—should be sent to us at once so that we, in turn, can bring them to the attention of your national legislators.)

The High School

The high-school problem is only in part the result of the deficiencies at the grade-school level. Consider the plight of the high-school teacher facing a class of 30 or 40 or 50, more than half of whom are conditioned against arithmetic or reading or spelling. Add to this an almost complete lack of modern facilities for effective teaching—laboratories that were out of date 10 years ago, few teaching aids, no modern equipment, a library that is more a museum or an archive—and not even a gifted teacher can long retain inspiration for teaching. Is it any wonder that fewer and fewer students are electing math-science courses and that the colleges complain of the deficiencies in background for entering students?

However, here, at the high-school level, is where each of us, even those of us who do not want cooperative effort on a national scale, can help, immediately. Every local area can have a *committee for technical education,* headed by an outstanding figure in that area and including representatives of all the local technical societies in the area, whose function it is to support education at the high-school level. This support can include the planning of courses in the new technologies of our times, teacher subsidization if necessary, procurement of modern lab-

oratory equipment, purchase of teaching aids, assistance in teacher indoctrination, student counseling fund raising, etc.

The first such committee is at work in Pittsburgh, Pa. It is not asking for federal aid; it will be asking for aid from *local* industries and individuals. It has already designed a course in instrumentation which will begin in a Pittsburgh High School in the fall term of 1957 (see letter opposite).

The College

Our college system is based primarily on private institutions. Most technical courses at the college level are abreast of the times—college courses in physics now include some nuclear and solid-state physics; most courses in mathematics now include early introduction to operators and statistical techniques; most chemical engineering courses now include servomechanisms and tracer chemistry.

However, one weakness does appear at the college level. The courses are adequate in theory—but not in *equipment*. The laboratory facilities of most colleges cannot be said to be up-to-date in terms of data handlers, computers, and instruments of all types (we have already mentioned that the high schools are a disgrace in this respect).

The seriousness and implications of this deficiency are not appreciated at the higher academic levels. It is true that mathematics is the language of the engineer or scientist—but instruments are his tools. Thus teaching the theory without the instrument produces a man who does not function well practically, who can not tackle many problems efficiently.

The college student must be made familiar with the wealth of measuring, recording, analyzing, and computing equipments ready for his use when he goes to work. With such knowledge he can rapidly become a capable and efficient engineer or scientist: he will waste little time arriving at answers he seeks; his brain will function at higher levels of thought and penetration.

But the average college instructor is too often contemptuous of the "commercial" equipment or advertisement; he too often fails to see that the instrument is the overlapping frame of reference tying the theory to the practice. The single most serious weakness today in technical college education is lack of emphasis on instrumentation—practical, available, commercial instrumentation.

Adult Education

There is one basic problem common to all levels of education, a problem caused by the rapid rate of change of technology and modern society. No matter what type of work or what level of work now being performed by any individual, it appears that the rapid change in society will affect his future job and work functions. Thus post-graduate or adult education becomes of increasing importance, and an entirely new philosophy and psychology is needed by almost everybody.

Today many students look forward to graduation as the end of formal education. Education today is not as much an adventurous search for knowledge as it is onerous apprenticeship. This is a serious indictment not only of our educational system but of our society.

The student should be made aware, early and continuously, that his education must never stop—or even slow up; that he should develop habits of reading in his chosen field so that he can keep abreast of changes in his society, and be prepared for them. He should be made aware of the fact that formal education should never cease; that a certain percentage of his time and his money must always be devoted to his own advancement; that this responsibility is one he owes to himself, his family, his country.

We conclude this discussion of education with three questions for every reader—

1. What percentage of *your* income is devoted to the purchase of books?

2. What percentage of *your* leisure time is devoted to your advancement via serious adult education such as night-school classes or correspondence courses?

3. Is there a technical education committee in your area, and are you helping it?

THE BOARD OF PUBLIC EDUCATION
ADMINISTRATION BUILDING
BELLEFIELD AVENUE AT FORBES STREET
PITTSBURGH 13, PA.

February 20, 1957

Mr. Milton H. Aronson
845 Ridge Avenue
Pittsburgh 12, Pennsylvania

Dear Mr. Aronson:

The Board of Public Education at a meeting held February 19, 1957, adopted the following recommendation of its Committee on Education:

"That approval be given the offering of technical courses in instrumentation and automation at Allegheny High School beginning September 1957; and that the Superintendent of Schools be authorized to work with a committee of consultants from local industry in preparing courses of study and in securing necessary equipment and teaching personnel."

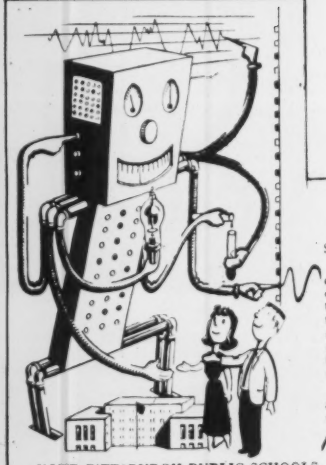
The Board also went on record to thank you and your committee of workers as follows:

"That the Board extend its thanks to the committee of consultants from local industry who have worked with the Superintendent of Schools and his staff in developing a program for technical courses in automation on the high school level."

Very truly yours,

H. H. Rothrock
Secretary and Business Manager

75,000 of these flyers will tell every school family in the Pittsburgh area about the new course in instruments and automation.



YOUR PITTSBURGH PUBLIC SCHOOLS
present **AUTOMATION**

"Eniac, Univac, Multa, Serva—
have turned us all topsy-turva!"

So commented SERVICE magazine recently.

Developments in the sciences and related engineering fields are, indeed, startling. School officials are aware of them. On February 19, 1957, the Pittsburgh Board of Public Education adopted the recommendation of the superintendent of schools that a new course in **automation** be started in Allegheny High School next September. It will be among the first such high school courses to be offered in the United States.

We have been hearing much recently about **automation**. It means the automatic control of machines. It involves such scientific processes and apparatus as electronics, nucleonics, industrial chemistry, data handling, instrumentation, computers, servo-mechanisms, and others. It is a rapidly developing and expanding field of human work.

We have been hearing also about the need for scientists and technicians not only to man our expanding industrial economy but to meet national defense requirements. Our modern civilization depends on science and engineering. In this atomic age, new scientific developments are taking place with increasing speed. Specially trained people are needed to invent, design, and operate the complicated machines on which our economy and national safety must depend.

In order to help meet this need for trained personnel, a committee representing industry, labor, engineering and technical societies, and research laboratories met with school officials. This group conferred over a period of several months. The result of their work is the new course in **automation** through which your Pittsburgh public schools will train young people to help alleviate the acute shortage of scientists, engineers, and technicians.

The course will provide students with laboratory-classroom experiences in instrumentation, electronics, and industrial chemistry. Students will learn measurement and control of sound, motion, liquids, gases, and the strength of materials. Through this program, the school will strive to attain the following objectives:

1. To increase the interest of students in modern technology
2. To induce students to enter college in the science and engineering fields
3. To train students for important positions as either technicians, junior engineers, senior engineers, or scientists depending upon their inclination, opportunities, and ability

This new course in **automation** will enroll only 12B students next September. Later it will be extended downward to the tenth and eleventh grades. To qualify for the course, students must have a keen interest in mathematics and science, and they must be enrolled in the high school curriculum which prepares them to meet college entrance requirements for engineering schools.

Interested students and their parents should plan to discuss the opportunities in this course with the school counselor. Those students who qualify will benefit themselves while helping to fill the need for trained scientific and technical personnel.

Earl A. Simmick
Superintendent of Schools

March 21, 1957
Pittsburgh, Pennsylvania

Dear D. R.*:

The flyer reproduced above, and the letter shown on the page previous to this one, shows that the first—and lowest—hurdle has been taken in the plan to introduce a course in modern instrumentation in a public high school.

You will hear much more about this exciting plan. The Pittsburgh Section ISA is now at work developing the process instrument phase of the course; the Pittsburgh Section of the National Machine Accountants is working on the computing and data-handling aspects; the Spectroscopy Society of Pittsburgh is developing the analytical end; the ASME, AIEE, IRE, AIChE, and other local societies are expected to work out still other phases. Pittsburgh is going to have the eyes of the nation on it—at least the eyes of all those interested in technical education at the high-school level. And they are really going to see something exciting!

Publishing is a long-term proposition. It takes years to earn thousands of friends—readers and advertisers—via services rendered. Most of you long-time readers could answer this question without even looking: "Who advertises on the back cover of *I&A*"? Well, Hammel-Dahl (whose advertising agency is Frank H. Deane of Frank H. Deane advertising, Providence, R.I.) has been on the back cover of *I&A* for ten years—since 1947. This is continuity—and confidence. Some companies have been with us for nearly 3 decades, but this may be a record for one spot. One decade down; many more to come.

In this personal letter to you each month, we try to tell you why certain material is selected for your reading—and to mention its significance.

First of all, this month we begin an important series of articles on "Regulators." There is much current excitement on the subject of automatic control—but the simple regulator today controls more pressures and temperatures and levels on more unit applications than all other types of control mechanisms combined. So read this series carefully if control is your field.

All you process control men also will be interested in the articles Microamperometric Titration (page 883), Ultrasonic Level Sensor (page 886), Bourdon Tubing (page 891), and Expansible Tube Valves (page 918). But—and this is an important but—you should be particularly interested in the three "computer" articles in this issue, for the following reasons: The article "Engineering Problems" shows how to evaluate a simple polynomial in eight easy steps on a general-purpose digital computer. (Next month you compare this with the DDA technique.) The article by Horton Harris (starting on page 895) portrays the state of the analog-computer art—and your eyes might open wide in wonder at the fine progress in this field with its many exciting implications for process control. We have told you often that there is an analog computer in your future, so this article applies to process men as well as computer specialists (the test of a really good article!). And the third article, by Jim Rogers, shows how easy it is to program the E101 digital computer. Now hear this: some grade-school students have actually programmed the E101 for arithmetic operations. So we titled this article "You Can Program This Desk-Sized Computer." Enough said, we are sure.

Hope this finds you (reading) well and happy this fine spring.

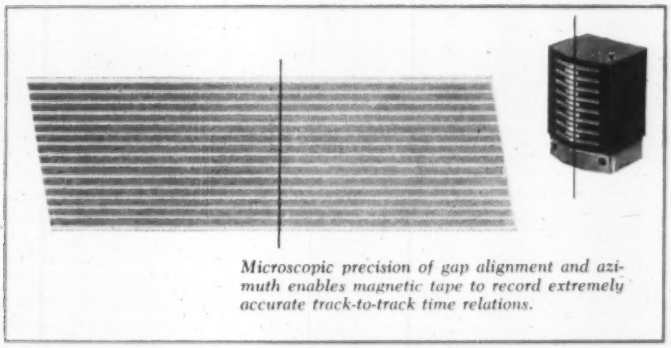
Cordially
Milt and the Editors

*Dear Reader

How many microseconds apart is "almost simultaneous"?

Here is how magnetic tape gets the answer

When things happen in the front of a jet engine, other occurrences in the rear follow in a flash – no pun intended, we mean in a fraction of a millisecond. Those who test jet engines have found that magnetic tape recording can be used to make a *milli*second look enormous – and to show even fifteen *micro*seconds as a significant interval. Transducers in key points in the front and rear of the engine feed parallel tracks on the tape. The amount of offset between parallel signals provides a measure of their relative timing.



Microscopic precision of gap alignment and azimuth enables magnetic tape to record extremely accurate track-to-track time relations.

For time correlation the head stacks on an Ampex Tape Recorder are like an "electronic tee-square." All of the gaps are in line within 1/10,000th inch. And gap azimuth is accurate to a minute of arc. Tape moves past the head at speeds up to 60 inches per second and multiplies the track-to-track timing accuracy accordingly. (But consult us at Ampex before you rely on simple arithmetical conclusions).

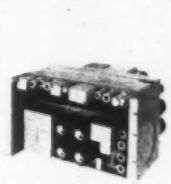
To read these time differences off in measurable form, the tape is reproduced at a small fraction of its original speed (1/32nd, 1/100th, etc. according to machine). It can be recopied onto another tape – be slowed down again – and then be recopied onto a visual recording on which small time intervals are magnified as much as 10,000 times.

If to you this particular example is more spectacular than useful, note that it is only one of numerous talents that magnetic tape has in tying together data and time. Perhaps some of these others fit your needs.

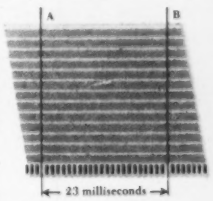
Are you interested in reproducing data in precise real time? Ampex Servo Speed Control can reproduce data with original timing held within two parts in 100,000. It doesn't matter if the tape stretches a little, or if your input power fluctuates from 60 cycles. Servo Speed Control holds a precision signal on the tape in step with a precision time source. At any instant these signals will be in phase within a millisecond or less (depending on tape speed).

Maybe you like your data recordings referred to the time of day. In any of several forms of digital coding, such information fits nicely on a timing track. The time code designates hours, minutes, seconds and even the milliseconds between. Commercial equipment is available for search and control. It can run the tape quickly to any minute and second you designate – handy if your recordings accumulate by tens or hundreds of thousands of feet.

If quick, accurate measurement of time intervals from a fractional second to a few seconds in length are your interest, magnetic tape recordings can make the problem as easy as counting to 1,254,391 . . . on an electronic counter. A series of pulses or sinewave oscillations are recorded on a time track parallel to the data tracks. As many as ten thousand per second can be recorded accurately and reliably. Electronic counting of these pulses measures time intervals to a required precision. There is no strain on your patience or your eyesight.



Ampex Servo Speed Control equipment as used on the FR-100 Recorder.



Electronic counting on a timing track measures time intervals between data

If you are concerned with accurate timing of data and would like to know further of magnetic tape's advantages, we will be glad to furnish additional information. Others of magnetic tape's capabilities will be discussed in this continuing series. Would you like copies mailed direct? Write Dept. BB-3135.

MAGNETIC TAPE APPLICATIONS BY AMPEX

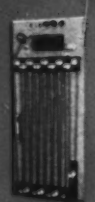
3

ONE OF A SERIES

Series FR-100

Series 800 Mobile and Airborne

Model FR-200 Digital



Tape Loop Recorder

Series FR-1100

INSTRUMENTATION DIVISION

AMPEX CORPORATION

FIRST IN MAGNETIC TAPE INSTRUMENTATION

934 CHARTER STREET • REDWOOD CITY, CALIFORNIA

District offices serving all areas of the United States and Canada; Foreign Representatives in countries around the world.

For more information circle **70** on inquiry card.

Mr. Scientist, What Is Your Answer?

EVAN W. INGRAM First Associate Superintendent, Pittsburgh Public Schools

AS a public school administrator among scientists—a lamb among the lions—what am I expected to say in opening* this convention? If the situation were the opposite and one of you as a scientist were this morning addressing a meeting of our more than two thousand Pittsburgh public school teachers, I know what we would desire from you: namely, that, as one at home in your own field, you fix our attention more intimately than can a cold printed page upon some foci of your work, upon some present emphases, or upon some new areas of study and so translate them as to give to them meaning for us as teachers and as citizens. May I then, simply by transposing the terms of the formula, recount for you some fundamental educational purposes and some current programmatic emphases, but permit you who are versed in objective appraisal to determine what relationship each of you, as a scientist and as a citizen, has to public education.

In today's civilization science has been catapulted into a position of prominence and prestige. This favored place in the family of occupations has not been conferred because of myriads of labor saving devices, great and small, which inventors have created. Such contributions to freedom from toil and even to personal vanity are not to be underrated; yet it is not because of these that the scientist is ringed with a halo. Rather it is because he has contributed immeasurably to our country's defenses, thereby preserving, at a time of national and international crisis, what we so glibly call our American way of life.

As a scientist each of you is a man of preeminence today. But may I ask you, for pertinent reasons, who were you, what were you forty, thirty or twenty years ago? If your personal history runs parallel to that of most other Americans of your day, you were the child of immigrants or of first-generation Americans and—partly due to the law but largely due to your parents' earnest desire that you profit from educational opportunities denied to them—you were attending school, a public school in nearly every instance. There you met and mingled with others of your own age whose background culturally, socially, religiously, may have been different from your own.

If you lived in an economically-deprived town you saw the first such sons—usually it was the sons—go away to college, maybe to return to the home town, maybe to make their way in another at pursuits undreamed of by their proud and sacrificial parents. In your town there may have been, as there was in mine, a shoemaker and his wife from Southern Europe whose lovely educated daughter married a college president and whose three sons became lawyers, two of them later as judges dispensing American justice, and the other as district attorney prosecuting violators of our country's laws. Or there may have been, as there was in mine, a butcher and his wife also from a Southern European country whose two sons are now prominent medical specialists in different metropolises, whose oldest daughter married, after college, a government official of high rank and whose two other daughters, having earned their bachelor's degrees in a liberal arts college, returned home to teach other boys and girls of the town to make the pattern and to weave the design that is America. It was grand, yes, that school after school across this land taught most boys and girls the rudiments of learning and made most of those who stayed past fourteen ready for higher education; but it was glorious that they made one common people out of so many diverse strands.

Though glorious, it is not strange that the American free public schools should produce a unified country. From time immemorial nearly every tribe has set its own schooling whether formalized or not, to indoctrinate its young so that its societal aims might be perpetuated. Our public school system went its precursors one better; it took and taught the young of its own land and of others to be one folk, taught them to appreciate, accept, maintain and even to extend democratic principles. This passing on of the American heritage is a primary function of our public school as much to be performed today as ever.

But, you say, there are so few immigrants and their children today; national quotas restrict their coming. True, but have we not as much need for unity now as formerly? Have we any better way of attaining it? Then, not as a scientist but as a citizen, have you

*Seventh Conference on Instrumentation for Iron and Steel Industry.

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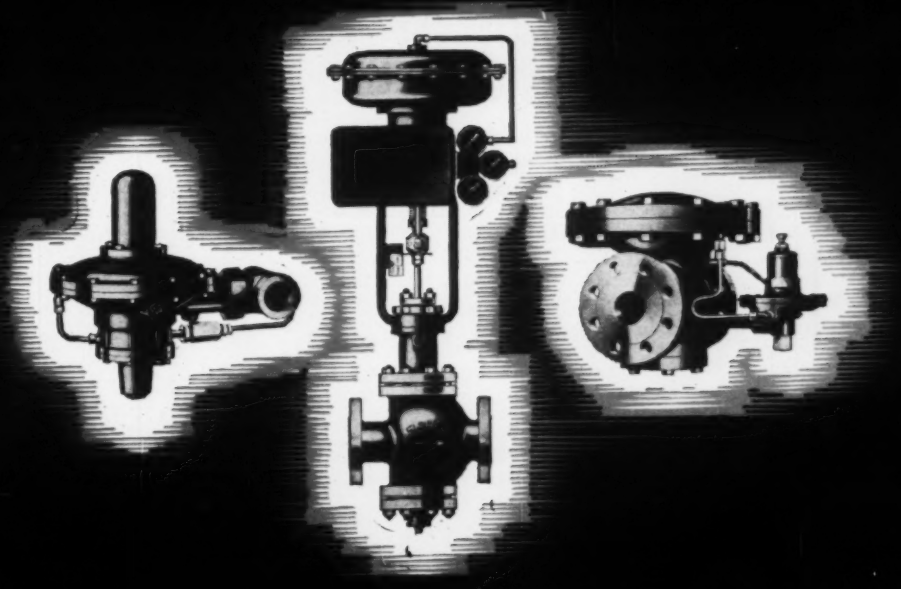

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an obligation to the free public school system? You can't walk away from such an obligation by saying that you are childless or that you pay taxes. You can't ignore it by sending your child to a private school to be with other youngsters more nearly like himself. You can't wash your hands of it by saying that "the schools aren't what they used to be." How do you know? Have you learned what you think you know from frequent visitation to your neighborhood school, from hearing its policy and program interpreted at a PTA, from your membership on your local school board or on a Citizens' Advisory Council? Mr. Scientist, you saved this nation's physical defenses by blasting out of existence the enemy's defenses, but you can't preserve our national unity by blasting the public schools. You, Mr. Scientist, have a civic obligation to give the public schools the same kind of study you give your professional projects, the same hard look, the same filtering of facts, the same critical judgement. Indeed you have!

In the realm of the immediately practical can you help your local district in providing more quickly for overwhelming numbers of children?

Buildings and children require money. Add to them the right number of good teachers for classes of the proper size and you will hear communities speak of the high cost of education. School financing requires minds expert in the knowledge of tax laws, in identifying sources of tax income, in budgeting, in the control of expenditures. In your objective way, by your methods of research, can you help your community assess its ability to pay for the program and the buildings it desires and needs for its youth?

Maybe through personal experience you can shed light on a most perplexing matter. You have attained stature among your fellowmen by being one of today's scientists. In what manner is this recognition best accorded? There are cries in the land that a single salary schedule is all wrong for teachers because it does not provide extra pay for the master teacher. Is it salary that delights you most? What forms of recognition other than, or in addition to, money do you find gratifying? You should have something worthwhile to say about this.

But you would press me further, I know. "What are you doing to prepare those you do have who wish to become scientists," you ask. For Pittsburgh I can give you an answer. By action of the Pittsburgh Board of Public Education in 1955 all subjects were regrouped into four separate curricula, the number of electives in each to be highly restricted. Of these curricula the one known as the academic offers three options: the Standard Option providing the usual college preparation; the Language Option, as its name indicates, stressing one or more foreign languages; the Mathematics-Science Option, in which you are particularly interested, demanding along with other subjects, four years of mathematics and two of science. In a few of our schools the ablest youngsters in mathematics now take their first year of algebra in the eighth grade. The first such class, having a highly satisfactory achievement, is now studying plane geometry at the ninth grade level. This acceleration means that a new and added course must be written for the ablest students in mathematics at the twelfth grade level. The number of periods in physics and chemistry have been increased from five per week to seven; in these areas, too, advanced courses will be established. This year two Pittsburgh classes through Station WQED are receiving live instruction in physics from Dr. Harvey White, a master teacher on leave from the University of California; next year other classes will be taught physics from films now being made by Dr. White, the regular classroom teacher also being present and later supervising the laboratory experiments.

Right now we are excited about introducing a course in automation next September. The genesis of the idea came from members of your own society, who, when their initiative had been warmly applauded, joined with certain school staff members to work out details. Through special equipment and a special teacher it is hoped that the program will increase the interest of students in modern technology, will induce students to go to college to become superior workers in the scientific fields of their own choice, and will train students for important positions as technicians, junior engineers, senior engineers or scientists with automation specialty. Announcement of the course was made last week; soon we shall discover the response in terms of enrollment. Through your professional organizations you can help us establish the program, help in furnishing equipment, help in finding a stimulating yet exacting teacher, help in evaluating the course.

But the program of any school is not enriched merely by the acquisition of more machinery, no matter how up to date it is. We can teach young men to run machines but we must teach them also to attack problems, among them the social problems which machines create.

"A smaller world requres bigger men," wrote Liston Pope, dean of the Divinity School of Yale University, in the *Saturday Review*. "A split atom and a split mankind cannot exist indefinitely on the same planet," he continued.

Can you then help us give the humanities a push too along with the sciences? Can you help interlard, as it were, the sciences with the humanities? Can you help us to put both in proper perspective?

This may not be a task for you as a scientist; but for you as a citizen it is. On this problem, as on others mentioned this morning, as well as on problems not stated, the public schools invite your interest and your support. They have created an intelligent citizenry and are not embarrassed now by staking upon it a claim for favorable reciprocal action.

Mr. Scientist, what is your answer?

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The regulator, a control instrument that uses no auxiliary source of power, is the most common type of process control device. Here is the first installment of a much-needed comprehensive treatment of regulators, beginning with the weight- and spring-loaded pressure regulator.

C. S. BEARD

Mechanically-Loaded Pressure

IN a previous series of articles on control valves, the *regulator* was defined as an instrument that operates from the line variable only—that is, an instrument that does not have a separate source of pneumatic or electric power. The term "controller" was reserved for those instruments which do use an external source of power to position a control valve.

It is the purpose of this series to review the existing types of regulators according to their use as regulators of pressure, temperature, level, etc. Certain types of regulators will be discussed as a class because of the specialized nature of their design for a particular service.

The *pressure regulator* is discussed first because the principles for control of static pressure are used in similar manner for regulation of temperature and other variables.

In the previous series on control valves, the valve body and actuator were treated separately; in pressure regulators these two parts must be considered together because the controlled variable (in this case the static pressure) acts directly on the diaphragm of the main regulator or the pilot regulator.

Classification by Loading Method

Loading methods constitute one important basis for classification of pressure regulators. These methods are:

1) Weight loading
2) Spring loading
3) Constant-pressure loading
4) Variable-pressure loading
5) Pilot control

The first two methods will be discussed here.

Weight Loading

The basic weight-loaded pressure regulator consists of a valve body and a diaphragm-and-weight assembly (Fig. 1-1). The inner valve is balanced by three forces —(1) the force exerted by the dead weight on the top must tend to open the valve; (2) the unbalanced force across the inner valve may tend to either open or close the valve, depending on whether the inlet pressure is brought in over or under the seat; and (3) the force of the downstream (or controlled) pressure acting on the effective area of the diaphragm must tend to close the valve. When the unbalanced force tends the close to valve:

$$W = A_v(P_1 - P_2) + P_2A_D \qquad (1)$$

in which W is weight loading in lb, A_v is area of valve plug in sq in, P_1 is upstream pressure in psig, P_2 is downstream controlled pressure in psig, and A_D is *effective* area of diaphragm in sq in.

When the inlet pressure is brought in above the inner valve so that the unbalanced force across the seat tends to open the valve, equation (1) becomes:

$$W = P_2A_D - A_v(P_1 - P_2) \qquad (2)$$

The foregoing equation is ideal and represents a balanced condition. Deviations from this ideal condition do occur and will be reviewed.

An example of the use of this formula follows for a case where flow tends to close the valve:

Assume: $A_v = 10$ (an approximate value for a 4″ valve), $P_1 = 40$ lb, $P_2 = 25$ lb, $A_D = 100$ sq in (a minimum to obtain necessary inner-valve travel).

$$W = 10\ (40-25) + (25)(100) = 2650 \text{ lb.}$$

The weight is obviously excessive, and bringing the pressure in above the seat would assist very little. This example shows the incongruity of the use of a weight-loaded, large-size regulator even for intermediate pressures. However, the following example shows a proper application:

Assume: $A_v = 1$ sq in; $P_1 = 10$, $P_2 = 2$, $A_D = 11$

Then: $W = 1\ (10-2) + (2)(11) = 30$ lb.

These examples show clearly that direct weight loading is applicable primarily to low-pressure service in which the $(A_v)(P_1-P_2)$ term is small.

Application of weight loading may be broadened by using a lever arm to increase the effect of the weight. Hung on the end of an arm (Fig. 1-2) the weight will increase the force according to the equation:

$$W_1L_1 = W_2L_2, \text{ or } W_1 = W_2\ (L_2/L_1)$$

in which W_1 is applied weight in lb, L_1 is lever arm from fulcrum to weight location in inches, W_2 is force applied to stem, L_2 is lever arm from fulcrum to stem. It is not difficult to obtain a large mechanical advantage by this method so that unreasonably large weights are not necessary.

General Controls Co.

Regulators

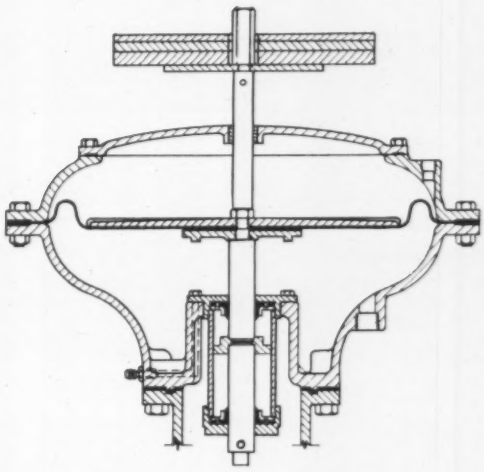

Fig. 1-1. Downward force of weight is used to balance upward force of static pressure acting on diaphragm.

Weight loading has the advantage that there is no change in the force exerted by the weight throughout the usable stem travel. Hence little change in controlled pressure occurs until the flow capacity of the valve is reached. Beyond this point (Fig. 1-3) the flow required exceeds the maximum that will pass through the wide-open body, and thus controllability is lost and the controlled pressure falls off.

Effect of Diaphragm Area

The equations given do not reflect the change in effective area of the diaphragm as the valve opens or closes. The manner in which this change in effective area affects the operation of a regulator is different from the effect upon a control valve.

The effective area of a flat (or large-convolution) diaphragm varies enough from its uppermost to its lowest position to limit greatly the useful stem travel of a regulator. The effective area of the diaphragm in Fig. 1-4 is at its maximum when the inner valve is wide open, whereas the diaphragm output force reaches a minimum when the valve is closed (Fig. 1-4). Many tests have been run by regulator manufacturers to determine this change in effective area, and different methods are used to interpret the effect.

A set of curves based upon tests by one manufacturer (Fig. 1-5) may be used to estimate the modification of published regulator capacity that must be made in order to realize a desired accuracy in regulation. This diaphragm-correction factor should be applied to any regulator using a conventional flat diaphragm. Most capacity charts for regulator sizing state the deviation from set point that may be expected for the flow rate given in the chart.

Change in effective area is caused mainly by the change in shape of the convolution at different positions. Flexibility of the diaphragm will contribute an area factor to some indeterminate degree. Heavy diaphragms necessary for intermediate or high pressures impede movements; laminated diaphragms will stand much higher pressures even when the thickness is reduced to minimize resistance to movement.

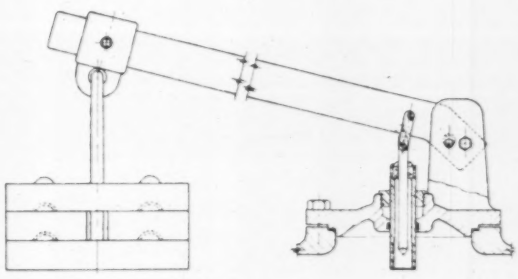

Fig. 1-2. Lever arm multiplies the force available from a given mass.

Spring Loading

A spring may be used instead of weights to load a regulator (Fig. 1-6). A spring offers the advantage of providing greater and more easily changed forces, and does not cause change or loss of regulation as

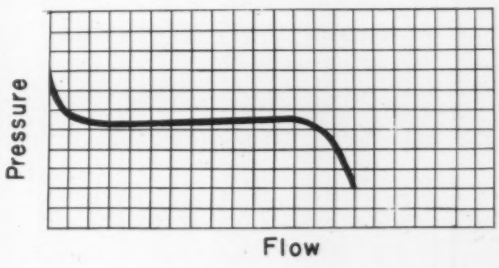

Fig. 1-3. Weight loading gives constant control until capacity of valve body is reached.

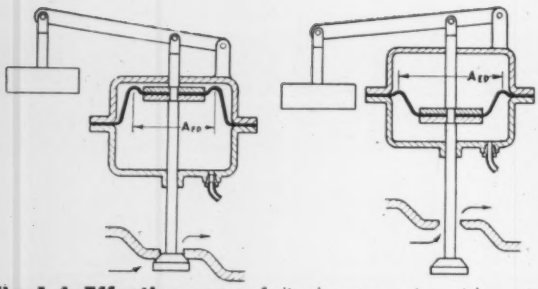

Fig. 1-4. Effective area of diaphragm varies with position of stem. When pressure is below diaphragm, effective area is greatest when in position shown at right.

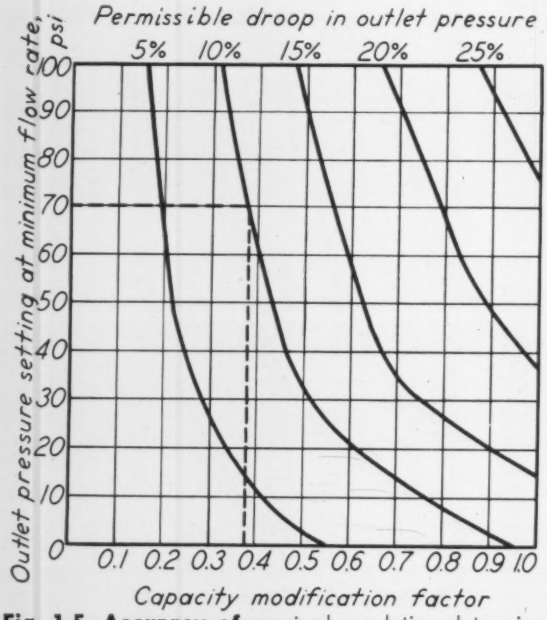

Fig. 1-5. Accuracy of required regulation determines permissible percentage of valve capacity which may be used. Curves show accuracy of regulation (droop) that can be realized by limiting the throughput (capacity modification factor) at any given outlet pressure setting at minimum flow rate.

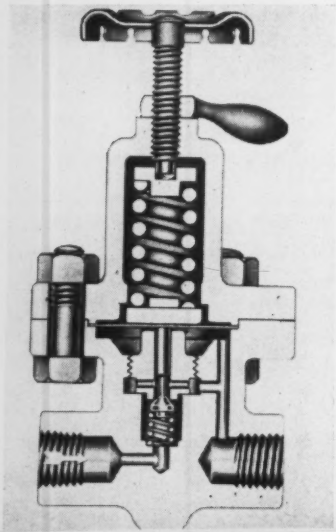

Fig. 1-6 In spring-loaded regulators spring opposes static pressure on diaphragm (and unbalanced force across the inner valve).

might result from inadvertent movement of the weights.

When spring loading is used, the weight W in equations 1 and 2 is replaced by the spring force ($S_R D$), and equations (1) and (2) become:

$$W = S_R D = P_2 A_D \pm A_v(P_1 - P_2) \qquad (3)$$

where S_R is spring rate in lb/in, D is compression of spring in inches, and the $\pm$ sign depends on whether the flow is brought in above or below the seat. Fig. 1-7 shows a regulator in which flow is brought in over the seat.

Port area (A_v) and pressure drop ($P_1 - P_2$) are inherent to the application; diaphragm area and spring characteristics are varied as design features. Selection of the proper values of these variables is based primarily on experience.

In most cases the required compression of the spring is equal to the desired travel of the inner valve. The minimum travel (h) required to obtain an annular space (between the inner valve and the seat ring) equal to the area of the seat ring is one quarter of the seat ring diameter (d) for an unguided valve finding its seat, as shown in Fig. 1-8. Wing-guided valves require slightly longer travel to obtain full flow.

Referring to Fig. 1-4, it can be seen that when the valve seats upwards, the stem area reduces the area for flow through the seat. This decreases the maximum capacity. The *percentage* capacity loss caused by the stem decreases as the valve size increases because the open area becomes proportionately much larger than the stem area in larger size valves.

The Spring

Springs used for regulator application must have a precisely linear spring rate throughout their travel. The lower the spring rate the more sensitive the regulator will be. The best way to show this is to design a spring-loaded regulator. Let us assume a single-seated valve with the valve seating down:

Seat diameter . . . 1.0″
Valve travel . . . 0.25″
Range of inlet pressure (spring range required) . . . 25-50 psi
Required accuracy . . . 5% of range, or 2.5 psi.

Let us select for trial a diaphragm with usable effective area of 20 square inches; hence the maximum total force is 50 psi times 20, plus an arbitrary 20%, which equals 1200 pounds.

Regulator sensitivity is the deviation in controlled pressure setting per inch of stem travel. In this case it is 2.5 psi in 0.25″ travel—or 10 psi per inch.

Spring gradient required is regulator sensitivity times effective area, which is 10 x 20, or 200 psi per inch. This is the spring characteristic required to limit the deviation in control to 2.5# in 0.25″ using a 20-sq-in diaphragm.

Reference to a spring-design slide rule or nomograph makes it possible to determine a wire diameter and mean diameter for the given load and reasonable wire stress. From the mean diameter and size of wire, the number of coils which will cause the desired spring gradient can be obtained. Using the given parameters, a spring of the following dimensions is found to be required:

Mean diameter . . . 2.50″
Wire diameter . . . 0.50″
Number of coils . . . 20.0

This would mean a spring with a solid length of 10 inches plus whatever length is necessary for the required travel, plus length necessary to change the pressure setting.

A study of spring calculations will show that the

spring is the main factor which determines the sensitivity and accuracy of the regulator.

Effect of Flow Through Body

The flow through the regulator body is a factor to consider.

Stem movement is caused by the controlled pressure acting on a diaphragm or piston, which acts against the weight or spring loading force. The desired pressure setting for a regulator in service at an existing flow rate is obtained by compressing or releasing the spring by use of a set screw until the pressure (shown on a gage in the controlled line) is at the desired value. Any change in controlled pressure will tend to open or close the valve until a new equilibrium occurs. For example, if the controlled pressure increases, the new equilibrium will occur at some slightly higher pressure because the spring has been compressed. (The amount of increase will be the stem movement required to create equilibrium times the spring gradient; this phenomenon was the basis of the spring calculation example in the previous discussion.)

The pressure drop across the seat due to flow through the body can tend to either open or close the valve, as has been described. This unbalanced force effect can be minimized by using a double-ported valve, a piston-balanced single seat, or a diaphragm-balanced single seat. In the calculations for weight loading and spring loading the letter A in the formulae was used for the *area upon which the unbalanced forces acted*. When either of the three methods of balancing are used, this value decreases so that the range of use and the size of the regulator can be increased greatly. However, it must always be kept in mind that tight shut-off (lock-up) cannot be obtained when a double-seated valve is used. Further, a double-seated valve usually is not completely balanced because in most designs one seat ring must be larger than the other in order to remove the inner valve. Fig. 1-9 shows a design using a sleeve within a cage or cylinder so that the unit is truly balanced.

Although attention has been called to variations from true balance, the unbalanced forces are greatly decreased in most "balanced" types, and the range of use of the double-seated pressure regulator is broader than for the single-seated regulator.

Weight of Parts

Weight of diaphragm plate, stem, and main valve are not serious factors in small valves; but the weight of a large diaphragm plate can be 30 lb, and a 12″ double-seated inner valve can weigh over 100 pounds. These forces must be considered. The weight of these parts will act as additional weight or spring force in the equations given. It is common practice to use an additional light spring to balance this weight so that it does not affect the main spring.

Conclusion

Although a simple design problem has been discussed, the purchaser of a regulator need not specify wire size, mean diameter, diaphragm-case diameter, etc. The company manufacturing the regulator will supply the unit that is suited to the operating conditions stated by the purchaser. However, this discussion has presented the few basic design details needed so that the field engineer can adapt regulators that he may have in stock to services of a slightly different type.

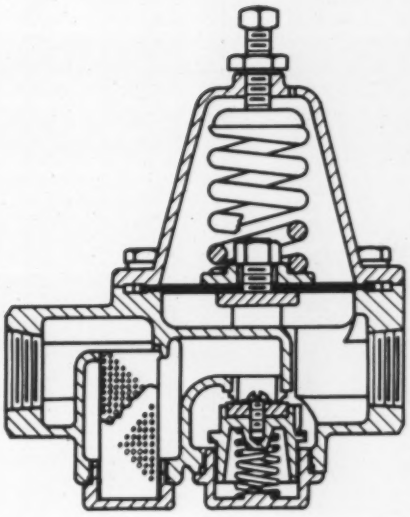

Fig. 1-7. Flow is brought in over the seat in this small regulator.

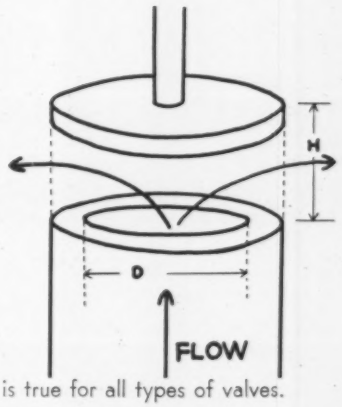

Fig. 1-8. When uncovering a circular port so that the flow exits through a cylindrical area, the area of the cylinder equals that of the circular port when $\Pi D^2/4 = \Pi Dh$, or $h = D/4$. Therefore, the vertical height h must be at least one-fourth of the seat-ring diameter for the flow to exit without further impedance to flow. This is true for all types of valves.

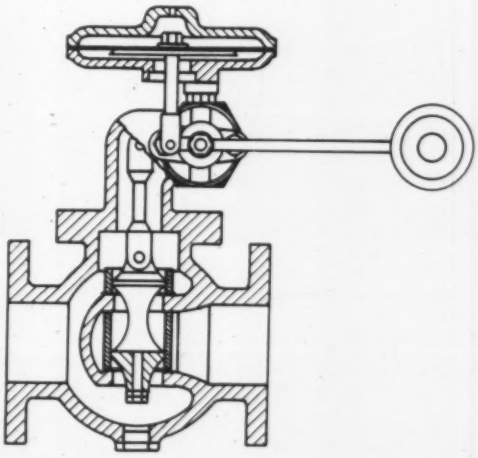

Fig. 1-9. Fully-balanced double-seated inner valve moves within a cage.

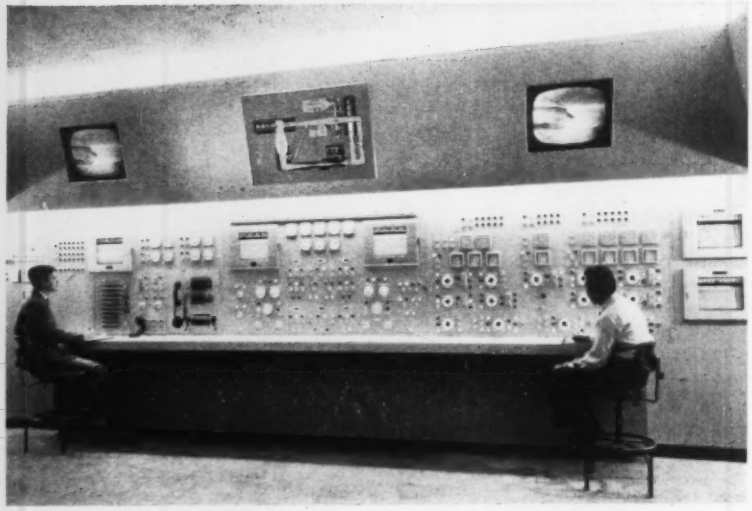

FIG. 1. ONE OF THREE CONTROL PANELS IN CONTROL ROOM of the Lewis Unitary Plan Wind Tunnel. The tunnel model (top center) shows position of the valves that control the operating cycle of the tunnel. The TV monitor screens can be connected to any of 3 closed-circuit TV cameras used to monitor tunnel components. (Photo courtesy NACA, LFPL)

Wind

FIG. 2. CENTRAL AUTOMATIC DIGITAL DATA ENCODER (CADDE) located at the Lewis Unitary Plan Wind Tunnel. CADDE translates the data signals it receives from the tunnel into binary-coded decimal numbers, which are recorded on magnetic tape, and may then be fed into an electronic computer for immediate reduction to usable form and transmitted to the control rooms for study by test engineers. (Photo courtesy NACA, LFPL)

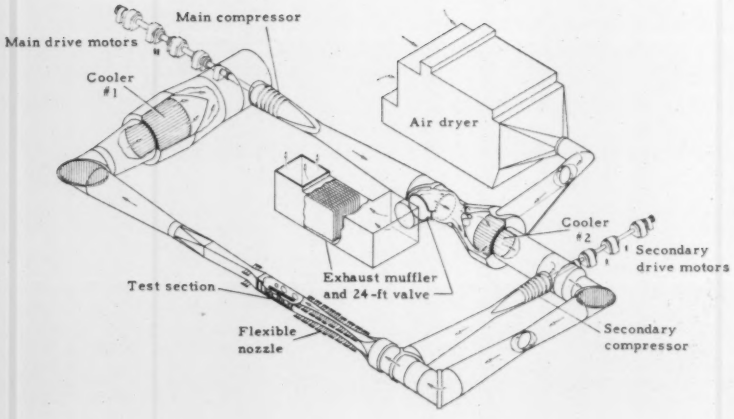

FIG. 3. SCHEMATIC showing compressors, air dryer, and test section.

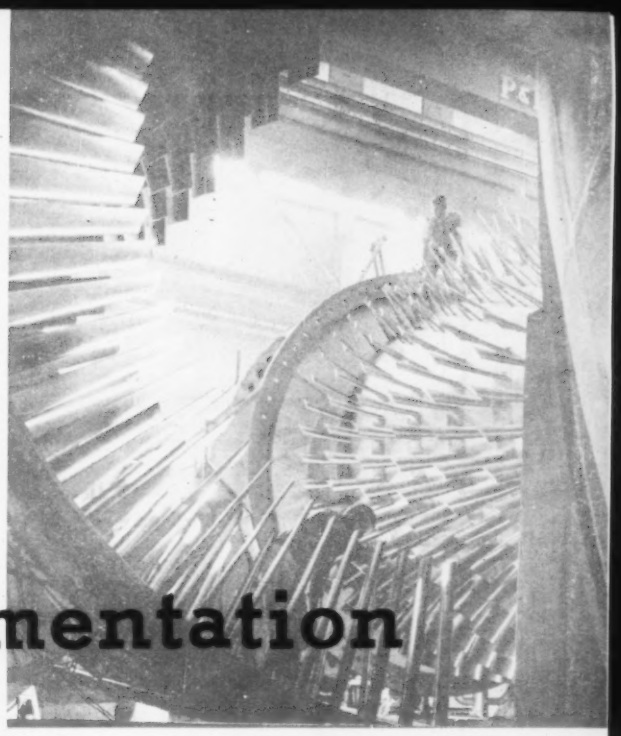

FIG. 4. BLADES OF MAIN DRIVE COMPRESSOR that drives air through the Lewis Unitary Plan Wind Tunnel. Stator blades (left), redirect the air from stage to stage as it is propelled by the rotor blades (right). Compressors deliver 2000 pounds of air per second, and are driven by seven electric motors which develop 250,000 hp.

Tunnel Instrumentation

In testing the performance of jet-engine air-intake apparatus, N.A.C.A. engineers at Lewis Flight Propulsion Laboratory encounter rapid pressure changes which are recorded by high-speed electronic recording instruments. Here are some of the reasons why direct-writing oscillography was the method chosen . . . and the ways in which the equipment is used.

Richard R. Steiner NACA Lewis Flight Propulsion Laboratory

AT the National Advisory Committee for Aeronautics' Lewis Flight Propulsion Laboratory in Cleveland, research engineers are using recording oscillograph systems in air-duct tests being run in their new supersonic 10′ x 10′ stainless-steel wind tunnel (so called because the actual test section is 10′ x 10′ high). The tunnel is one of the newest facilities at N.A.C.A., the government's top aeronautical research organization, which provides the nation's military services and the aviation industry with advanced design information. To establish proper design criteria, Lewis engineers test prototypes at Mach numbers from 2.0 to 3.5 at simulated altitudes up to 30 miles.

Air Intake Tests

A design criterion in any aircraft engine is its air intake apparatus. In turbo-jet engines, capable of speeds double or triple that of sound and of altitudes of many miles, the air-ducting design problem becomes greatly magnified.

The actual tests, in simplified form, are programmed as follows: A test model of a jet-engine air intake apparatus, of a shape and size believed to be workable at certain speeds and altitudes, is mounted on a huge elevator one floor below the actual test section of the wind tunnel. Behind the air inlet and attached to it is a variable mass-flow-control unit, shielded in the same shape and contour as a jet engine. Inside the model are the pickups for all test variables.

After the air inlet apparatus and the control unit have been so mounted, they are raised into the wind tunnel itself (Fig. 5).

Once the test has begun, at a predetermined speed and simulated altitude, Lewis engineers have two ways of observing the results. Visually, they can get some idea of what is going on in the wind tunnel by using closed circuit television. Cameras focused through portholes into the test section pick up images and relay them to the nearby central control room. Actual air flow can be observed and photographed by using the television cameras with a schlieren optical system. This method, however, neither records quantitative results nor measures actual pressures.

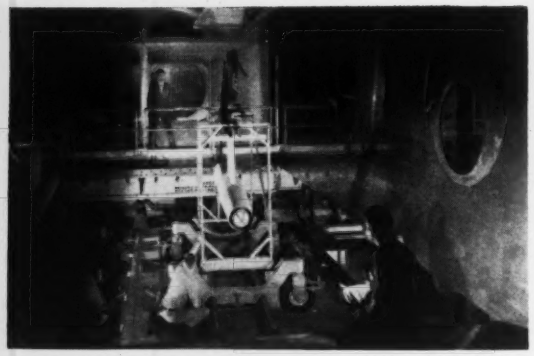

FIG. 5 DOWNSTREAM VIEW from the nozzle of the wind tunnel, showing a ramjet model being raised into test position by the elevator-floor. (Photo courtesy NACA, LFPL)

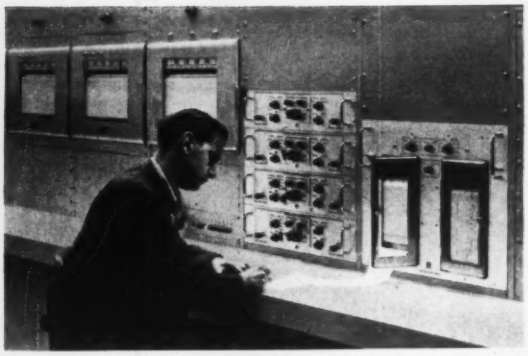

FIG. 6 DUAL-CHANNEL INK-WRITING oscillographs (right) record pressure variations from 0 to 100 cps. (Photo courtesy Brush Electronics)

The other methods of observation utilizes the instruments within the test unit itself. Located inside the model at various points are as many as 300 air-flow pressure-measurement tubes to feed air down to a point near the control room. These tubes are used to record steady pressure in their immediate area, but do not transmit or indicate rapid pressure fluctuations. For rapid pressure changes, a high-speed recorder system is required.

High-Speed Recording System

Rapid pressure variations must be recorded accurately for necessary analysis. The frequencies involved are well above the capabilities of conventional pressure-measuring equipment; therefore, the use of high-speed recording electronic instrumentation was required. Because of the nature of the N.A.C.A. testing program, the engineers need instantly visible records as well as permanent records. Use of cathode-ray oscilloscopes and photographic-type galvanometer recorders employ a developing process which cannot yield instantly visible records. Direct-writing oscillography suited the requirements.

Recording of rapid pressure fluctuations now is accomplished with dual-channel ink-writing oscillographs which provide chart records of frequencies from 0 to 100 cps (Fig. 6). The pressure variations are sensed by strain-gage pressure transducers mounted in air intake tubes located inside the test unit. Fig. 7 shows a typical gage circuit and mounting details. Operating in temperatures as high as 300°F, these transducers convert air pressures to electrical signals and give faithful electrical reproductions of pressure variations. The transducers are coupled to the oscillographs through amplifiers and pressure variations are instantaneously put into permanent record form, as shown in Fig. 6.

Before each tunnel run, the amplifier is checked and balanced. Then, for calibration, a known pressure is applied to the transducer and the output is read on the recorder.

After the test run, the recorder charts are studied to determine the amplitude and frequency of the pressure fluctuations. Amplitude is determined by using the calibration mentioned. As the recorder runs at a constant known speed, the frequency of the fluctuations can be determined from the record.

By consulting the oscillograph, the operator in the control room can tell in an instant if the high-frequency air-pressure fluctuations are becoming too strong or too frequent. The charts are used also in analyzing results of experiments and tests on the jet engines and components.

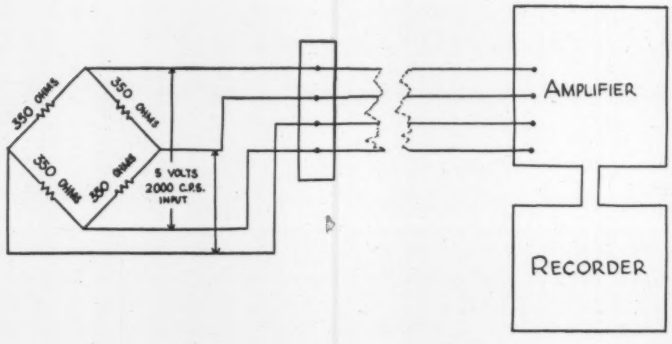

FIG. 7. TYPICAL GAGE circuit for pressure measurement.

Microamperometric Titration of
SULFHYDRAL GROUPS

Frequently situations arise in chemical analysis in which a very limited amount of material is available. This microamperometric titration apparatus requires only small amounts of material and is capable of determining 10^{-6} milliequivalent of ^{-}SH when 0.001M $AgNO_3$ is used as a titrant.

SUMNER LEVINE
General Engineering Laboratories
American Machine & Foundry Company

AMPEROMETRIC TITRATION of sulfhydral groups, introduced by Kolthoff and Harris[1], has found wide application in chemical and biochemical investigation. The method was applied to proteins by Benesch and Benesch[2], and to the estimation of active and sulfhydral groups in enzymes by Barron and Levine[3].

The heart of the apparatus is a vibrating platinum electrode (Fig. 1) constructed by soldering one end of a platinum wire to the moving element of a 24-volt buzzer. The apparatus described by Rosenberg and Perrone[4] was found to suffer from a number of disadvantages which the present design overcomes. Increased sensitivity of the platinum electrode is obtained by flattening the end dipping into the sintered glass funnel. An insulating sleeve of glass insures the independence of electrode current from the extent of electrode immersion in the funnel. Initially, the electrode must be immersed up to the level of the insulating sleeve. This way, current flowing to the electrode depends only on the concentration of the silver-ammonium ion—not on the change in volume from adding the titrant. The current tends to increase with electrode vibration until a plateau is reached. The vibration is increased by a Powerstat until current reaches this plateau.

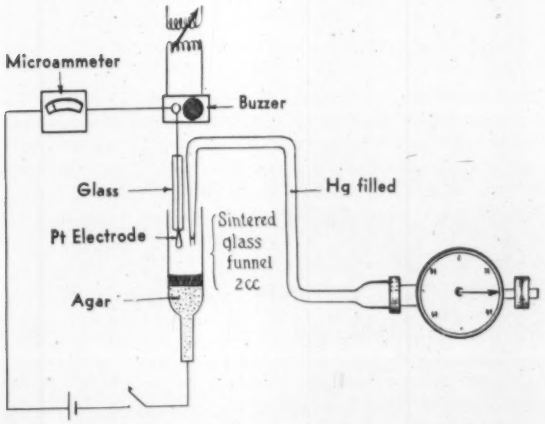

Fig. 1. Schematic representation of titration apparatus.

The titration cell is a 2-cc sintered-glass funnel of medium porosity. When smaller volumes are to be titrated, smaller funnels may be employed. Electrical contact is provided by means of an agar in 0.1M KNO_3 plug placed in the stem of the funnel. The plug is connected to the standard Hg-Hg I half-cell, by means of a length of rubber tubing filled with saturated KCl. The salt bridge is protected at the standard cell by means of an agar in saturated KCl plug.

The titrant is introduced by means of a Gilmount ultramicro buret of 1-cc capacity. These burets are graduated to 0.001 milliliter and may be estimated to about 0.0002 milliliter. After a measured amount of titrant has been added, the current is read by completing the circuit by means of a button, and reading the microammeter.

Determination of the end point can be made by the conventional method of extrapolating the linear portion of the current-vs-titrant curve to the base current, or, more conveniently, by means of the expression:

$$V_b = a\,(i_b - i) + V$$

where, V_b = the extrapolated volume of titrant corresponding to the initial current i_b; a = slope of the linear portion of the curve; V = an arbitrary volume of titrant lying on the linear portion of the curve; i = the current corresponding to V.

This method requires that only two points on the linear portion of the current-vs-titrant curve be determined, from which the slope, a, can be calculated.

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1. Kolthoff, I. M. and Harris, W. E. "Amperometric Titration of Mercaptans with Silver Nitrate Using the Rotating Platinum Electrode." *IND. & ENG. CHEM. ANAL. ED.* vol. 18, no. 3, March 1946, pages 161-162.

2. Benesch, R. and Benesch, R. E. "Amperometric Titration of Sulfhydryl Groups in Amino Acids and Proteins," *ARCH. BIOCHEM.* vol. 19, October 1948, pages 35-45.

3. Barron, E. S. G. and Levine, S. "Oxidation of alcohols by yeast alcohol dehydrogenase and by the living cell. The thiol groups of the enzyme." *ARCH BIOCHEM.* vol. 41, November 1952, pages 175-187.

4. Rosenberg, S. and Perrone, J. C. "Amperometric Titration of Sulfhydryl Groups. Microgram Analysis." *ANALYTICAL CHEMISTRY*, vol. 22 no. 9, September 1950, pages 1186-1187.

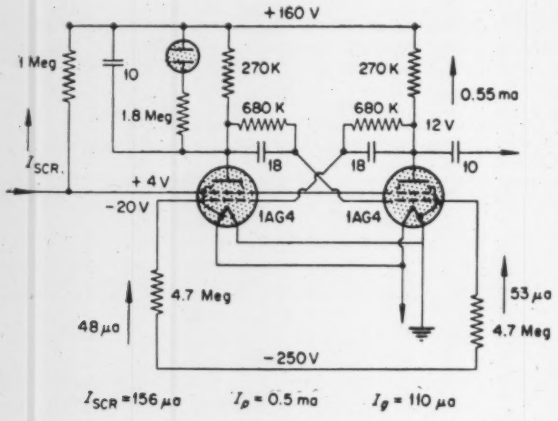
ELECTRONIC

CHARLES F. KEZER
Key Electric Corp.
and
MILTON H. ARONSON
Instruments & Automation

BINARY SCALER USES SUBMINIATURE TUBES

The principle of "hard bottoming" (see "Hard Bottomed Scaler," *I&A*, April) is used in this circuit, this time with filamentary-type pentode tubes. By choosing components to obtain grid currents of 115 ua in the conducting tube, with screen current of 160 ua, the tube operates at a plate voltage of only 12 volts. This relatively high screen-current minimizes variations in plate voltage during tube life. Still higher screen current could have been used to obtain a harder bottoming action, but it was desired to keep screen currents low to provide sufficiently high input impedance for trigger pulses, which are applied to the screens.

Plate voltage of the non-conducting pentode is 115 volts. Other circuit voltages are shown on the diagram, for the state in which the right-hand tube is conducting. When a negative input trigger is applied to the common screen connection, the conducting (right-hand) tube is cut off by regenerative action, and the circuit changes state. Output to the next stage is taken from the right-hand plate. The neon bulb connected to the left-hand plate indicates when that tube is conducting.



Input: Negative triggers with rise time of about 0.5 usec, and decay time-constant of about 3 to 5 usec; trigger should exceed 4-v amplitude for about 3 usec. Square pulse of 3-usec duration are ideal.

Resolution: Circuit will resolve pulse pairs 15-usec apart with a 20-v peak trigger. When grid-catching diodes are used to hold the grids at —6 volts, the circuit will resolve pulse pairs of about 4 usec, but the input triggers must now be different. They should be the same amplitude as before but should have much shorter duration so that the pulses exceed 4 volts amplitude for about a microsecond. It can be seen then that the amplitudes given are minimum and that the circuit will work best with about a 20-volt spike with the proper decay constant (3 usec for the unaided circuit and about 1 usec for the diode-caught circuit).

Output: 103 v swing.

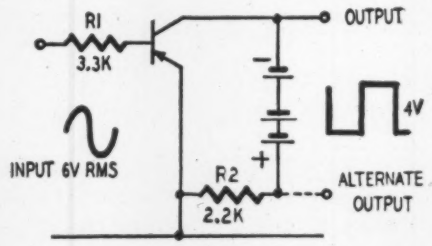
Power Supply: 0.72 ma at 160 v dc; 0.1 ma at —250 v dc; 80 ma at 1.4 v dc.

Source: C. C. Harris, P. R. Bell and G. G. Kelley, Oak Ridge National Lab., Oak Ridge, Tenn.; also *IRE Transactions—Nuclear Science*, March 1956; also *Review of Scientific Instruments*, Aug., 1956.

SIMPLE VOLTAGE REFERENCE USES Hg CELLS AS STANDARDS

This simple circuit uses a transistor (CK722 or OC70) as a switch to chop the 4-volt output of three 1.3-volt mercury cells, and thus provide a 60-cycle square wave of 4-volt amplitude that can be used as an oscilloscope calibrator or other reference. Output is said to be more accurate and stable than VR-regulated calibrating sources, and has low output impedance.

Input: (6-v rms from standard filament transformer) provides switching action. If transformer center-tap is grounded, only 3-v signal will be available; however, circuit works equally well (only difference being a less-steep rise and fall of waveform). Resistors do not affect precision; hence can be 10% values.



On positive half cycles, collector is cut off, there is no drop across the 2200-ohm resistor, and the full reference voltage appears across the output. On negative half cycles, the base swings negative, the base-emitter loop draws full current, the collector-to-emitter voltage approaches zero, effectively shorting the output and causing the reference voltage to appear across the 2200-ohm resistor. Output is then zero. Thus the output square wave swings between —4 v and zero. A square wave is also developed across the 2200-ohm resistor; this voltage swings between zero and +4 v, and may be used as an alternate output.

Accuracy: Approx. 2%.

Output impedance: 2200 ohms, either output.

Supply: Three Mallory mercury RM cells Rm-625-RT or equivalent. Drain is negligible with no input signal, 0.9 ma with signal.

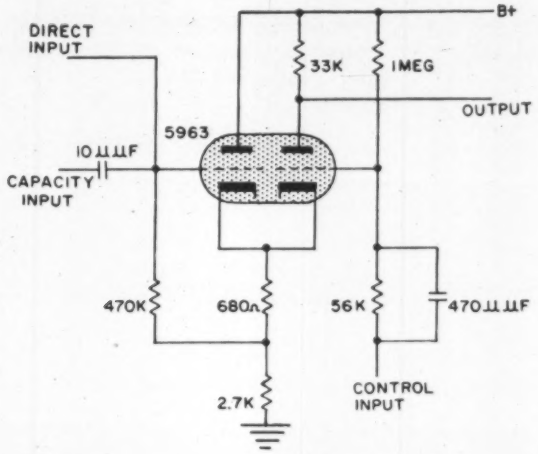
Source: Edwin Bohr in *Radio-Electronics*, February, 1956.

CIRCUITRY

The circuit is the heart of all electronics. Here are 5 more basic and interesting circuits. Unless marked, resistors are in ohms, capacitors in microfarads.

NON-INVERTING GATED AMPLIFIER

A gated amplifier is one that operates only when "enabled" by a timed pulse, or gating signal. A signal of between —10 and —100 v applied to the left-hand grid (either input) of this cathode-coupled amplifier appears at the output when a —10 v control signal is applied to



the control input (gird of right-hand stage). When control signal of —100 v is applied to the right-hand grid the tube is cut off, closing the gate.

Gate opening time: 10 usec.

Gain: 1 to 1.5

B Supply: 200 v at 9 ma.

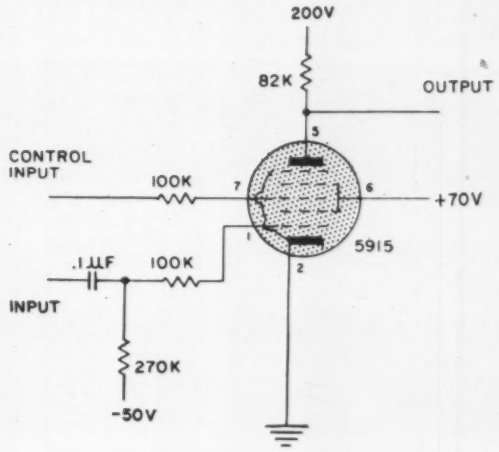
Output: 92 v peak-to-peak max.

Source: Circuit Z-9007, EECO Production Co., 827 S. Vermont Ave., Los Angeles 5, Calif.

PENTAGRID COINCIDENCE GATE

A coincidence gate is a gate circuit which is open only when two signals are applied simultaneously or in coincidence. The control voltage and signal input are applied to the two grids of a pentagrid tube. The control-input voltage to pin 7 (usually derived from a flip-flop) is held at —20 v; this keeps the tube cutoff. A positive signal pulse applied to the normally cutoff first grid will produce output if the control-input voltage is simultaneously brought to zero. Rise time can be improved by reducing the value of the plate resistor.

Input signal: 53-v positive pulse minimum; 12-usec minimum duration.



Control signal: Gate open, 0 v; Gate closed, —20 v.

Gate opening time: 10 usec.

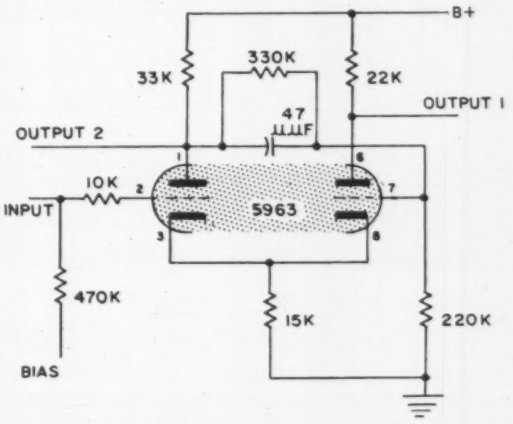
Output: 180 v negative pulse (no load); Rise time, 5 usec minimum; Delay time, 10 usec minimum.

B Supply: 200 v dc at 2 ma, 70 v dc at 14 ma, and —50 v dc bias.

Source: Circuit Z-90023, EECO Production Co., 827 S. Vermont Ave., Los Angeles, Calif.

SQUARING CIRCUIT USES REGENERATION

This squaring circuit converts sine or complex waveforms into square or rectangular waveforms. Input sensitivity and output waveshape depends on and can be adjusted by the bias supplied to left-hand grid, which determines clipping point. Circuit both clips and limits because tube runs from cutoff to saturation. Like a one-



shot multivibrator, the regenerative action (via the common cathode resistor) causes rapid squaring action at beginning and end of each half cycle of input.

Output 1: 100-v pulse or square wave with rise time (negative going) of 1 usec; decay time (positive going) of 3 usec.

Output 2: 120-v pulse or square wave.

Input: With bias between 50 and 75 v above pin 2, minimum input signal is 15 v p-p for signals from 0 to 20 kc; 30 v p-p at 100 kc.

B Supply: 200 v, at 3.5 ma.

Source: Circuit Z90001, EECO Production Co., 827 S. Vermont Ave., Los Angeles 5, Calif.

Ultrasonic Level Sensor

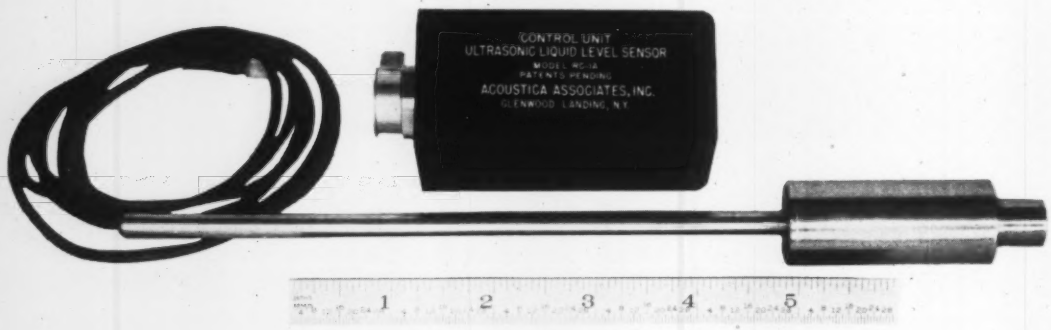


Fig. 1. Ultrasonic liquid-level transducer comprises simple sensor plus single-stage transistor circuit.

Operating on the principle that an ultrasonic transducer in contact with a liquid presents a terminal impedance appreciably different than obtained when it is purely "air-loaded," this new sensor energizes a relay when the level passes the transducer.

ROBERT L. ROD
Acoustica Associates, Inc.

EVER-PRESENT NEED for a reliable, simple liquid-level sensor is met by a newly developed ultrasonic probe*, comprising a solid cylinder of barium titanate approximately 1″ long and 0.5″ O.D. This cylinder has a fundamental half-wavelength resonance of about 90 kc. The titanate cylinder is bonded axially to a similarly dimensioned slug of stainless steel which has a nodal clamp at its midpoint. This clamp enables the entire titanate assembly to be supported within a surrounding sealed aluminum or stainless-steel case (measuring 0.875″ O.D.) without restricting the motion of the vibrating element. When assembled, the emergent end of the solid metal slug contacts the liquid being gaged. The over-all length of the probe, including the protuding quarter-wave slug, is slightly over 2.5″; it weighs less than 5 ounces.

The mounting arrangement eliminates the need for pressure-sealing material normally required to support a transducer, and reduces the number of dissimilar materials used in the probe (aside from wire) to three—barium titanate, aluminum or stainless steel, and a bonding agent joining the transducer to the slug.

It is possible to realize impedance changes of up to 10:1 between conditions of air and liquid loading. With the titanate transducer, a reliable impedance change of at least 4:1 is achieved over the full temperature range from −270° to +200°F. The probe operates reliably when immersed in liquids ranging from liquid nitrogen to boiling water. For higher temperature operations, a small magnetostriction transducer is employed in place of the titanate. The ultrasonic sensor responds instantaneously and is entirely safe when used to gage hazardous, explosive liquids. The sensor operates in fluids such as lox (liquid oxygen) and JP4 and has operated satisfactorily in free-flowing solids and oils of various viscosities.

Paper presented at the 1957 IRE National Convention, Technical Session on Ultrasonic Engineering.

* Patents Pending

Sensor Circuit

The impedance change in the element is sensed by a simple electronic circuit consisting of a single silicon-junction transistor, a relay, and eight subminiaturized components (Fig. 2). The transistor is in an oscillator circuit, with the transducer placed between the emitter and ground, in series with the operating coil of the relay. When the sensor is unloaded (out of a liquid), its impedance is of the order of 2500 ohms; under this condition the transistor circuit oscillates at the natural frequency of the transducer. Immediately upon loading the transducer with liquid, the impedance rises above 10,000 ohms, causing the transistor circuit to stop oscillation. The resulting change in emitter current between the oscillating and non-oscillating conditions is more than sufficient for reliable operation of the sensitive relay wired in series with the

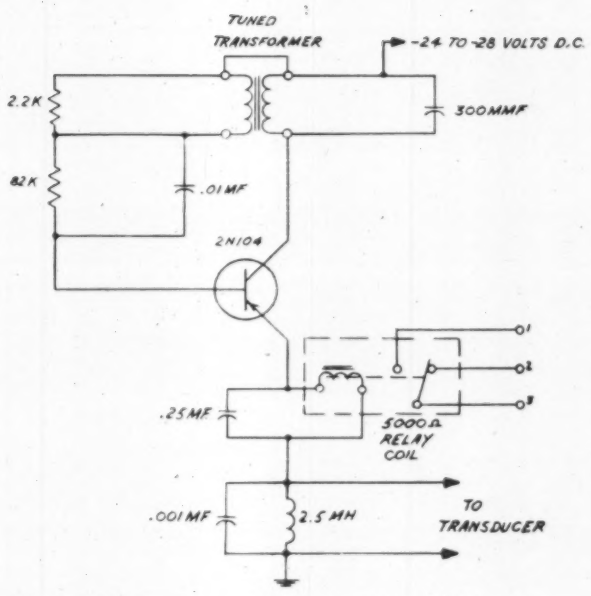


Fig. 2. Basic sensor circuit for 90-kc $BaTiO_3$ transducer.

transducer. Through choice of proper operating frequency, droplets clinging to the sensor do not cause false readings.

The complete level sensor, including transducer and control circuitry (Fig. 1) weighs under 12 ounces.

Power

Power requirements are about 20 milliwatts in the normal unloaded condition, and 100 milliwatts when sensor is immersed and control relay is energized. This power is ordinarily obtained from a 24-30 volt d-c source, but for a-c operation an auxiliary rectifier is supplied. Low power drain makes this sensor suited for airborne applications.

Applications

Applications are found in airborne systems and in process applications involving liquid-level control. No temperature-correction circuits are required, nor are any adjustments needed to compensate for any variables whatsoever. The sensor is completely sealed in stainless steel and can in no way contaminate foods and beverages. Operation is not dependent upon conductivity, pH, temperature, pressure or density of the liquid being monitored; there are no moving parts other than the relay contacts. Groups of these probes can be used at discrete levels to control filling and emptying operations.

Acknowledgments

The author acknowledges the assistance given by members of the engineering staff of Acoustica Associates, Inc., in developing this product. In particular, Messrs. D. R. Church, M. Kenny and M. Damast contributed many design ideas.

Attention Industry:

Technical Institutes Are Source for Technicians

MANY of our readers may share the common belief that privately owned electronics technicians schools emphasize radio-TV servicing, as indeed they did in the years up to and immediately following World War II. But such is no longer the case. The majority of students trained in electronics in today's technical institutes become technicians for industrial firms.

Penn Technical Institute, Pittsburgh, Pa., is an example of the change in this field. Founded in 1947, it has a daytime enrollment of 170 students; night-school enrollment of 260. Its basic course is titled "Electronics" and the objective is training to produce electronics technicians. The day-school course length is 21 months; evening school 31 months. The 35 students graduating every 3 months find more jobs available than there are candidates.

Where do they go? The vast majority go to electronic industries (IBM, Rem-Rand, GE, Curtiss-Wright, Link Aviation, Capital Airlines, Sperry, Magnetics, Inc., Wastinghouse, Western Electric, etc.). Only a few go to TV stations. *Rarely do the students go into TV servicing.* Further, most students accept employment outside the city of Pittsburgh, embarking on truly professional careers.

The technical institutes of America are doing an important job in developing trained electronics technicians. Industry would do well to consider the subsidization of such training for its employees, preparing for the future by upgrading its work force. The technical institutes stand ready.

INSTRUCTOR JOHN M. ROPAR at PENN TECHNICAL INSTITUTE, demonstrates build up of industrial control circuits on laboratory bread boards. Course given by the Pittsburgh, school emphasizes instrumentation.

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Engineering Problems

Evaluating a polynomial is a typical engineering-type problem. Here are the eight steps in a simple program for evaluating a polynomial on a general-purpose digital computer.

MARTIN L. KLEIN
FRANK K. WILLIAMS
HARRY C. MORGAN
Rocketdyne Div.,
North American Aviation, Inc.

DIGITAL ENGINEERING PROBLEMS are of two basic types—(1) those involving numerical work, such as series expansions and polynomial evaluations, and (2) those involving differential equations. A special type of digital computer known as the *digital differential analyzer* (DDA) has been designed for rapid and simple solutions of differential equations as well as continuous functions. The general-purpose digital computer, which has been described in detail in previous discussions, also can be used for most types of engineering problems, and there is some overlap of application between the DDA and the GP digital computer in the field of engineering-type problems. In general, the general-purpose machine should be used where a table of stored values must be consulted, or where phases of the computation must be done so rapidly that the slower rate of function generation of the DDA cannot be tolerated. We will show here how a general-purpose computer (the ALWAC) is used to solve a polynomial. In the next chapter we will show how the DDA is used for solving differential equations.

Evaluating a Polynomial

Let us evaluate the polynomial

$$y = ax^4 + bx^3 + cx^2 + dx + e$$

It can be rewritten as follows:

$$y = \{[(ax + b)\ x + c]\ x + d\}\ x + e$$

Note that two arithmetic operations are repeated over and over:

First, x is multiplied by a factor—first a, then (a + b), etc. Let us call the factor Σ and the product P. That is, $(x)(\Sigma)=P$.

Secondly, a different coefficient ($coeff_i$) is added to P

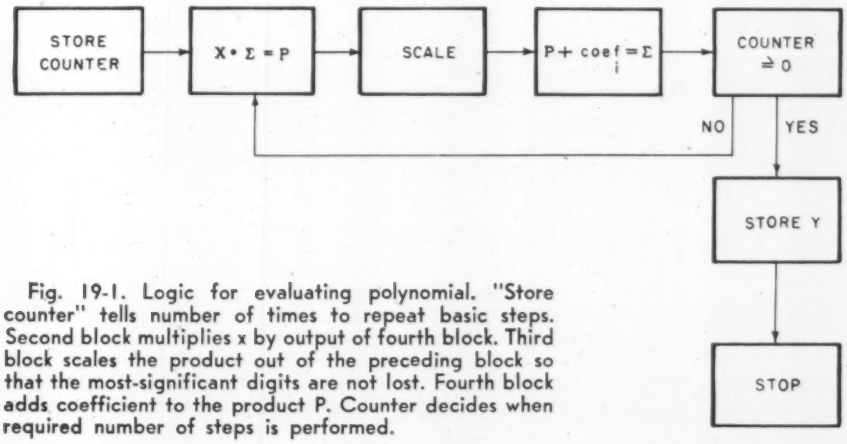

Fig. 19-1. Logic for evaluating polynomial. "Store counter" tells number of times to repeat basic steps. Second block multiplies x by output of fourth block. Third block scales the product out of the preceding block so that the most-significant digits are not lost. Fourth block adds coefficient to the product P. Counter decides when required number of steps is performed.

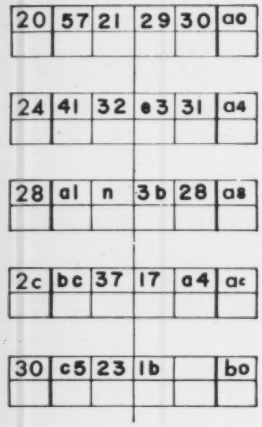

Fig. 19-2. Complete programmed data sheet has ten instructions.

each time the product is formed. That is, $P + coeff_1 = E$, which then is the new factor that is to be used to multiply x.

These two steps are repeated four times.

In our previous discussion we learned the commands and operation of the ALWAC general-purpose computer. Let us program the ALWAC here for this polynomial problem.

Logic Chart

Fig. 19-1 show the required logic in block form. The store counter tells the number of times we repeat the process indicated (in this case 4 times).

The $(x)(\Sigma)=P$ block indicates that x is multiplied by whatever is fed back from the Σ block.

The *scale block* is required to keep the value of the product P in the B register because the multiply command that will be used (e7) automatically produces a double-length intermediate product. The most-significant digits would be lost if the intermediate product exceeds the B register in length. Hence the product is scaled (shifted to the right) so that the most-significant digits are retained. This is done by shifting n bits to the right, where n is the number of bits in the multiplier x.

Fig. 19-2 shows the programmed data sheet for accomplishing the solution.

Data Sheet

The first instruction, 57, will set the count contained in address 21 into the E register. The second instruction, 29, will clear any count which may be in register A. This instruction 29 is actually instruction 28, which is listed in the table of instruction codes, plus one. The addition of the one to the 28 instruction allows us to use the address part of the half word (which will be unused because instruction 28 is a no-address instruction) and to place a second instruction 30 in this half word. The instruction 30 will exchange the contents of the A register for the contents of the B register. The next instruction 41, contained in address 24, will place the contents of address 32, which is a, into the B register. The next instruction (e3) will place the contents of address 31, which is x, into the D register, and then multiply the contents of the B register by the contents of the D register and place the answer in the register AB.

Instruction a1 in address 28 *right shifts* the product contained in register AB, n binary bits to the right. Bits leaving A enter the left end of B. Bits which overflow from the right end of the B register are lost. Address a8 contains the instruction 3b. Instruction 3b actually is no-address instruction 3a plus one. The instruction 3a means to exchange the contents of the A and D registers. The addition of one to the 3a instruction tells the machine that the next half word will also contain an instruction instead of an address. This instruction is 28, which will clear the contents of the A register. We have now cleared the x out of the D register.

The next instruction bc in address 2c is actually the instruction bd less one. When we subtract one from this instruction, we tell the machine to make an automatic address modification on the address which follows this instruction. This automatic address modification instruction subtracts the contents of the E register from the address 37 which in this instance results in 33 and adds the contents of address 33, which is b, to the contents of the B register.

Address ac contains the next instruction (17). This subtracts one from the content of the E register, which is 4, and gives 3 as the result. The address following instruction 17 tells the computer to go back to address a4 for the next instruction as long as this result is not zero. However, if the contents of the register are zero, the machine proceeds to the next instruction in address 30. The instruction 17, however, allows the computer to go back over the computing loop and reuse the instructions in addresses a4, 28, a8, and 2c until the last mathematical operation has been performed. When the contents of the E register are zero, the computer goes to the next instruction which is c5. Instruction c5 will place the contents of the B register, which is the desired answer, into address 23. The next instruction 1b contained in address bo tells the machine that the computation is over and stops the operation.

State of Programming Art

It should be evident at this point that machine programming is a complex art in itself, and programmers who obtain experience in working with automatic digital computers become particularly adept in finding ingenious shortcuts in all types of programs. Because of the complexity and work entailed in programming problems of any length, the professional societies of machine programmers have fortunately established a policy of interchanging information and actual machine programs, and this has made it possible to progress at a fast rate in extending the useful programs available for machines. In fact, it is now possible to purchase a machine and at the same time obtain all of the necessary programs for normal machine usage.

Certain programs are in such common usage that they are ordinarily stored permanently in some part of the machine memory. For example, when one wishes the cosine of an angle, one might only insert the angle and the machine calculates the cosine by a conversion expansion. All of the operations to perform this expansion are retained internally and the instructions stored are known as a *subroutine*. A considerable effort has been expended to simplify machine programming by retaining inside the computer the necessary subroutines to execute most of the logic. Just how well this has been done has been proven recently by the fact that elementary grade students have been able to program a computer to do simple operations.

Bourdon Elements Require Special Tubing

In the 108 years since the Bourdon tube gage was first introduced it has accumulated a bibliography of about 150 references. Despite the fact that the Bourdon tube itself is the heart of the gage, only seven references seem to deal to any extent with the *materials* used for the tube. Here is a presentation of the special problems that have to be taken into consideration in the choice of suitable materials.

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Superior Tube Company

THE PRESSURE GAGE named for Louis Bourdon, commonly believed to be its inventor, apparently was invented by a man named Schinz in 1849. Whoever invented it, the Bourdon-tube gage is now an indispensable part of modern industrial instrumentation. It is one of the most widely used devices for measuring pressure.

Cold-drawn tubing used for the Bourdon element is made from carefully selected and conditioned raw stock. It is specially processed to remove stress-raising imperfections on the surface of the tubing because the constant flexing of the Bourdon tube element in the gage subjects it to stresses which may result in metal fatigue and eventual failure. A smooth surface also lessens the chance of corrosion.

Although it never has been officially designated as such, there is a definite category of tubing that has become commonly known as *Bourdon quality*. Such tubing is likely to have fewer and less severe surface imperfections which might contribute to failure by corrosion or metal fatique.

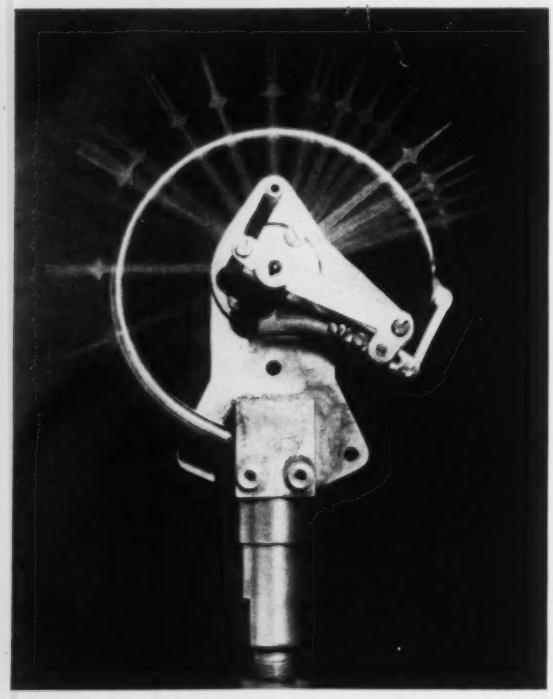
Bourdon-Tube Principle

In general, the Bourdon tube is oval or elliptical in cross section (Fig. 1), and is coiled to form a "C," a spiral, or a helix. It is sealed at one end and connected at the other to a capillary tube or passage through which the pressure is transmitted. The forming operation is done by the Turks-Head method on a draw bench.

Under pressure, the confined gas or liquid tends to force the walls into a circular cross-section, causing the coiled tube to straighten slightly. This produces a quasi-linear deflection, known as the tip travel (Fig. 2) at the sealed end of the tube. This tip travel is translated by mechanical or electrical linkage into

FIG. 1. BOURDON TUBING is produced by cold drawing the material to the correct round, then forming by means of shaped rolls and mandrels on a multiple roll setup. This is commonly referred to as the Turks-Head method.

FIG. 2. UNDER PRESSURE, the confined fluid tends to force the walls of the oval or elliptical cross-section into a circle, causing the coiled tube to straighten out slightly. The "tip travel" is translated by linkage and movement of the gage into indication on the face of a dial.



registrations on the face of a dial or chart.

It is this constant movement of the metal resulting from changes in pressure that can give rise to serious stresses. Small surface imperfections tend to spread and deepen, ultimately resulting in failure of the tube. Among the imperfections which can weaken the tube are inclusions and seams, carburization and decarburization, rough or corroded surface, chatter marks, and variations in wall thickness. Use of *extra quality tubing* for Bourdon tube elements greatly minimizes the possibility of tube failure from these causes. The cost of the tubing is minor compared to the cost of the complete instrument.

Materials for Bourdon Tubes

At least 13 analyses of tubing are used for Bourdon gages. They may be grouped by the means used to obtain the required temper of hardness for a specific application:

The *strain-hardened* group includes (1) cartridge brass, (2) trumpet brass, (3) phosphor bronze, (4) silicon bronze, and (5) austenitic stainless steel (AISI types 304 and 316).

The *precipitation hardened* group consists of (1) beryllium copper, (2) "K" Monel, (3) Ni-Span "C," and (4) Inconel "X".

The *heat-treated* group (quenched and drawn) comprises (1) low alloy steels (AISI types 4130, 8630), and (2) martensitic stainless steel (AISI type 403 modified). Alloys of the first groups are supplied in the work-hardened condition to the gage manufacturer's hardness specifications. Ordinarily they do not require heat treatment after coiling, but may be stress relieved. The copper-base alloys are relatively easy to form. Because the materials in this group show some drift, hysteresis, and relaxation, they are not generally used in high-precision gages but do find extensive application in low-pressure instruments.

Alloys in the second group are the most difficult to form of any of the Bourdon-tubing analyses and, therefore, should be purchased in the softest possible condition. After forming they are precipitation-hardened for best operating characteristics. As they are likely to distort during heat treatment, jigging or clamping is usually necessary. These alloys produce high-precision Bourdon tubes with good creep resistance, low hysteresis, and low relaxation. Fatigue life is usually excellent.

Alloys in group 3 are usually supplied in the soft annealed condition and are intermediate between the other two groups in workability. They are quenched and tempered after forming to obtain the necessary mechanical properties. They can be used for high-pressure applications and show exceptionally good creep, hysteresis, and zero-shift characteristics. Endurance limits are high, provided the surface of the tubing is free of imperfections. Particular precautions are taken with the low-alloy steels in group 3 because of the greater possibility of defects appearing in the raw stock of this material.

Raw Stock

The raw stock is produced in an electric furnace rather than by the open-hearth process because the

analysis and cleanliness of electric-furnace steel can be more closely controlled than that of any other type.

The inner diameter is bored to remove decarburization and surface imperfections. Sufficient material must be removed from the ID to insure freedom from internal defects when subjected to a flattening test used in the trade. There must be no complete decarburization on the ID surface (decarburization is undesirable, particularly in light walls, because it lowers the fatigue resistance of the tubing).

Samples are cut in half longitudinally and flattened between parallel plates until the distance between the plates is three times the wall thickness.

Tube Processing

The outer diameter of all Bourdon tubing is ground (to remove imperfections) before the shaping operation. On all materials used for Bourdon tubing, 0.003" to 0.004" is ground off the OD. The grinding operation also removes the "woody" surface from the tubing. This surface condition does not indicate internal defects. However, it is suspected of lowering fatigue resistance.

After tube reducing and before the first draw, all stainless-steel raw stock which will be processed into Bourdon tubing is pickled.

Ordering Tubing

When ordering round tubing (which the instrument manufacturer will shape into a Bourdon tube), the tubing can be ordered only to two out of the three possible dimensions—OD, ID, or wall thickness. When ordering shaped tubing to fabricate into Bourdon elements, he can specify only three of five dimensions —either the major OD, the major ID, or the minor OD, minor ID, and wall thickness.

When ordering shaped tubing, allowance must be made for an increase in tolerance of major OD over OD tolerance of the round tubing from which it was formed. For example, if the total tolerance spread on the round OD was 0.004" ±0.002", when the tube is drastically shaped by rolling flat (Fig. 1), the tolerance on the major OD will increase by the product of π times the OD tolerance in round (±0.002"), or approximately ±0.006".

Tolerances for shaped tubing are given in Tables 1 and 2.

Bibliography on Bourdon-Tube Materials

1. W. R. Clendinning, "Pressure-sensitive Elements for Gages and Instruments," *Product Engineering*, vol. 4, 1933, pp. 143-144.

2. H. Yamasaki, "Study of the Material of Bourdon Tubes Used in Pressure Gages," (in Japanese), Japanese Government Railways, *Research Bulletin* No. 29, vol. 24, 1936.

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5. J. B. Giacobbe and A. M. Bounds, "Selecting and Working Bourdon-tube Materials," *Instrument Manufacturing*, vol. 20, 1952, pp. 130-132, 136-137.

6. J. B. Giacobbe and A. M. Bounds, "Material Selection Factor Significant in Bourdon Tubes," *Journal of Metals*, vol. 4, November 1952, pp. 1147-8.

7. "Chrome-moly Steel Tubing Cuts Bourdon Tube Rejects," *Product Engineering*, vol. 24, March 1953, p. 139.

FIG. 3. THE INNER DIAMETER of raw stock for Bourdon tubing is examined. The ID is bored to remove decarburization and minor mill imperfections. Tool marks resulting from the boring operation must be of such minor nature that surface lapping and flaking will not occur on further redrawing.

Table 1—Major and Minor OD Tolerances for Bourdon and Commercial Flat Ovals, Ellipticals and Partial Rounds.

Outside Dimension	Minor OD Tolerance	Major OD Tolerance
Up to 0.25"	±0.002"	±0.002"
0.126" to 0.250"	±0.003"	±0.002"
0.251" to 0.375"	±0.003"	±0.003"
0.376" to 0.500"	±0.004"	±0.003"
0.501" to 0.750"	±0.004"	±0.005"
0.751" to 1.000"	±0.004"	±0.008"
1.001" to 1.250"	±0.004"	±0.012"
1.251" to 1.750"	±0.004"	±0.016"

Table 2—Other Tolerances for all Shaped Tubing.

Length Tolerences		Straightness	Wall Tolerance
Cut Length	Tolerance	All Sizes	All Sizes
Up to 11.9"	+ 1/32" — 0"	1/600	±10%
1' to 4'	+ 1/16" — 0"		
4' -1" to 10'	+ 7/32" — 0"		
10'-1" and above	+ 1/8" — 0"		

NOTE: A complete bibliography on Bourdon tubes and pressure gages has been compiled by the American Society of Mechanical Engineers in ASME paper No. 53-IRD-1. Covering the period 1849-1952 it contains 143 references exclusive of abstracts.

The newest analog-computer techniques include problem check, time-scale check, voltage-scale check, patchbay verifiers, pot-loading turrets, patchbay switching, automatic recording, and a complete Auto-Control system for setting potentiometers, reading the settings, measuring voltages, and operating the computer. These refinements indicate dramatically the present state of the analog-computer art.

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Reeves Instrument Corporation

New Techniques for

GENERAL-PURPOSE ELECTRONIC ANALOG COMPUTERS have established themselves as vital engineering tools. However, analog computers have been at a disadvantage with respect to digital machines in efficient use of machine time—analog computers commonly remain tied up for long periods of time with one problem, even while trouble-shooting or results are being evaluated, simply because it takes so long to insert the problem and check out the computer. To help computing centers keep up with the ever-increasing load of problems, new analog-computer concepts have been introduced on the "400 Series" REAC* Computer so that a problem can be put on and checked out in minimum time.

Problem Check

Checking out computer setup, and testing for proper operating condition of all components, has always been time consuming. A single misplaced patchcord, one pot set wrong, or one component that is not working properly can lead to hours of wasted computer time.

The invention by Reeves, in 1954, of the first commercial "Problem Check" system provided a routine check procedure built into the machine for solving this problem (Fig. 2). Working directly from the problem equations, and without disturbing the problem setup in any way, the following can be checked:

a. The diagramming of the problem from the equations.

b. The patching of the problem from the diagram.

c. The setting of all potentiometers and function generators.

d. The operation of computer components used in that particular problem.

In general, the check indicates not only whether something is wrong, but also where the fault lies.

The simply-performed problem check operates as follows: Pressing the "Problem Check Static" button automatically does two things. First, it disconnects the output of every integrator from its load and substitutes in its place a "Problem Check Potentiometer" onto which any desired initial conditions can be inserted. At the same time, each integrator is converted to a summer by connecting a resistor across its feedback path.

A condition of static equilibrium now is established in the problem patched onto the computer, based on the initial conditions which have been set on the Problem Check Potentiometers. (Due to the use of separate Problem Check Potentiometers, any fictitious initial conditions that may be convenient may also be used without disturbing the original problem setup in any way.) As it is an easy matter to solve the original problem equations for any compatible set of assumed initial conditions, a check on the correctness of all steps in the problem setup can be had by comparing the actual values of the variables with the values which the equations say they should have.

A further mode is also provided to check the time constants in the integrator circuits being used in the problem. Pushing the "Problem Check Dynamic" button automatically converts all integrators back to their normal form and allows them to integrate for a precisely controlled period of time. Any discrepancies in the time constants can be detected quickly.

Problem check solutions can be prepared in advance, and to use them effectively the same procedure should be followed as is customary on digital computers. The problem should be put on the computer and a Problem Check run off immediately and compared with the precomputed results. If something turns out to be wrong that is not immediately obvious, the problem should be taken off the machine, leaving it free for someone else to use. The operator then can trouble-shoot the incorrect problem from the Problem Check results. Meantime, the machine can be working on the next problem.

Time-Scale Check

The "Time Scale Check" system, introduced by Reeves about a year after "Problem Check," provides

*Reeves Electronic Analog Computer registered trademark.

ANALOG COMPUTATION

an important supplement to the earlier system. It basically tells the operator by a quick and easy check, which does not disturb the computer setup in any way, whether or not the time scaling of his problem is such that any computer component is operating beyond its linear range.

The system operates simply. It merely doubles all capacitor values used in the problem so that the problem runs at exactly half its former speed. If any component used in the problem is not operating in its linear range, the solution will not be the same as that obtained at normal speed.

The comparison of normal and half-speed runs is made quickly and simply by slowing down (by half) the time axis of the 6-channel recorder or plotting board used for recording the output. Normal and half speed plots should then superimpose exactly.

The Time-Scale Check should be run as soon as a problem is put on the machine. If the time scaling shows up to be wrong, the problem should be taken off the machine; rescaling should be done while the computer is working on the next problem.

Voltage-Scale Check

Just as the Time-Scale-Check system checks the time scaling of a problem, the *Voltage-Scale-Check* system checks the voltage scaling. Analog computers work to best advantage when all components operate at voltage levels of reasonable magnitude. If the voltage scaling is such that an important variable does not ever exceed a voltage level of perhaps a fraction of a volt, problem accuracy can deteriorate, and this inaccuracy is hard to detect by normal means.

The Voltage-Scale-Check system, suggested originally by Mr. Milton Warshawsky of Wright Air Development Center and built first for the WADC computer, provides a routine checking method to make sure that all components are operating at reasonable *minimum voltage excursions.*

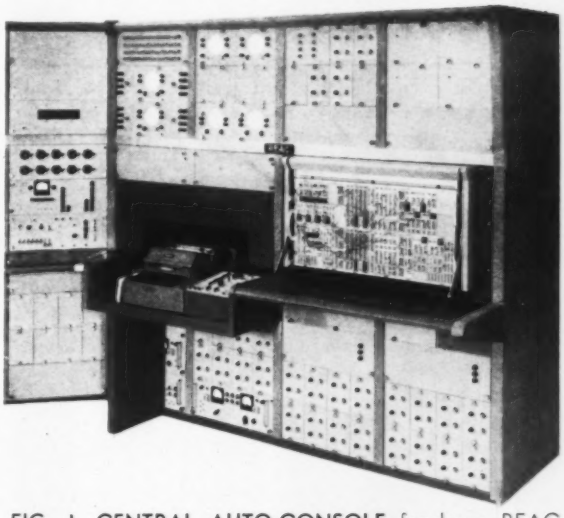

FIG. 1. CENTRAL AUTO-CONSOLE for large REAC computer.

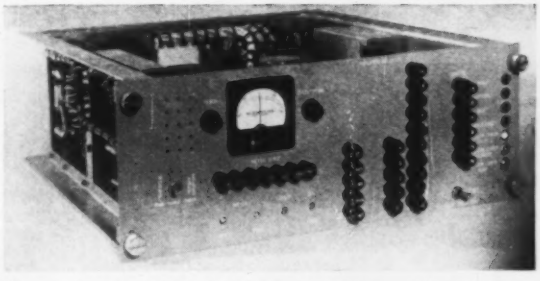

FIG. 2. COMPUTER CONTROL PANEL, showing controls for problem check and time-scale check.

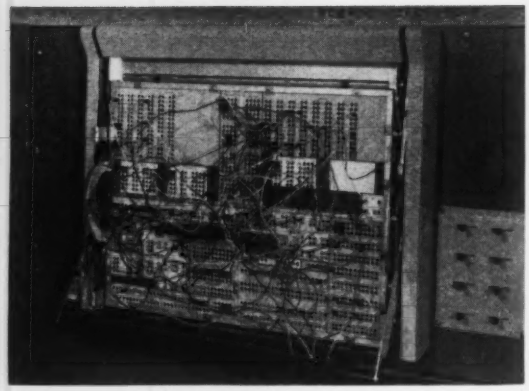

FIG. 3. PROBLEM PATCHBAY for typical analog computer.

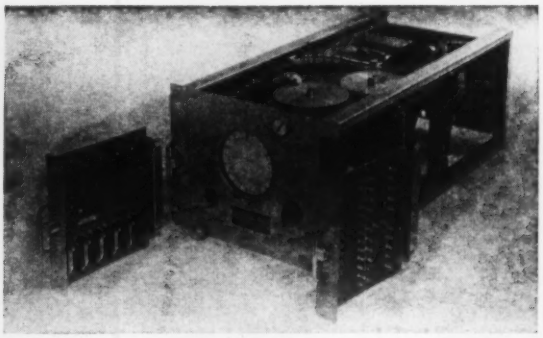

FIG. 4. PLUG-IN POT-LOADING turrets for multiplying servos. Turret at left has miniature pots for maximum convenience.

The system consists of a series of so-called *Minimum Excursion Indicators*, each consisting of an electronic switch and a pilot light. One of these Minimum Excursion Indicators is connected to every critical point in the computer. At the beginning of a problem run all the pilot lights are on, but as soon as the voltage in each monitored point reaches some predetermined value (which may be set anywhere from 2 to 50 volts) the corresponding light goes out. At the end of the problem run, any light that remains on indicates a point in the circuit at which the variable never reached the predetermined critical voltage—that is, a point where the scaling should be rechecked to assure the most efficient use of the computer.

Patchbay Verifier

The patchbay verifier, also originally suggested and prototyped by Mr. Warshawsky of WADC, is a sophisticated checking device intended primarily for large computer centers. It scans every patchbay point to which a connection is made and prints out on tape the designation of the computer element represented by that point and every other computer element to which it is connected, using a suggestive English print-out.

The advantage of automatic patchbay verification can be appreciated by appraising the complexity of typical patching, as in Fig. 3.

A corollary advantage of the patchbay verifier is its use in storing the problem setup for future use. A complete record of all patchbay connections can be stored on tape. As the designations are completely non-technical, the patchbay setup can be quickly reproduced at a later date even by nontechnical personnel.

This reproduction process is further aided by a coded checking system which provides totals and subtotals during the verification as an aid in comparing original and reproduced setups. There is also a self-checking feature in the verifier, which will discover any malfunction in itself.

Short of doing the entire problem over again by other means, no checking system can ever provide 100% assurance that all is correct. However, the above four checking schemes will locate the majority of operator errors and machine malfunctions. They provide simple and routine methods for checking out a problem with a minimum of machine time, and greatly increased effective use of the computer.

Operator Aids

1. Patchbay Switching

Avoidance of problem switching functions on front panels of individual computer elements is an important aid in eliminating setup errors when changing from one problem to another. In the "400 Series" computer, all switching is done on the patchbay—e.g., servos on or off, resolvers to polar or rectangular mode, conversion of inverters to high-gain amplifiers, application of voltages to potentiometers, etc. When the operator inserts the patchbay, the computer is then set into the proper modes for that particular problem. He does not have to worry whether the previous shift has left a resolver in the wrong mode or has switched different servos on or off, etc.

2. Plug-in Pot-Padding Turrets

Tapped-pot servos provide a convenient method of performing function generation, especially if the function is to be multiplied simultaneously by a problem variable. However, setting up the functions can be time consuming, and it is important that the computer not be tied up while this is being done.

The "400 Series" computer, therefore, introduces the concept of pot-loading turrets which plug into the front of their respective servos (Fig. 4). Padding turrets thus can be made up in advance and plugged into the computer at the same time as the patchbay is put on.

The time-saving importance of this feature is great. If much servo function generation is to be done, the time required to set potentiometer loading by other methods can be significant.

3. Automatic Recording of Recorder Calibration Data

Another time-saving "first" for the "400 Series" computer is the automatic recording mechanism in-

FIG. 5. SIX-CHANNEL RECORDER provides automatic recording of calibration data.

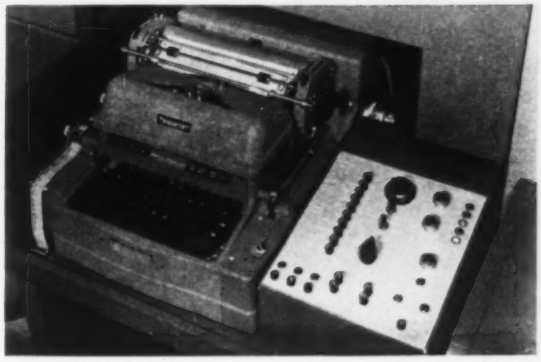

FIG. 6. FLEXOWRITER and control panel for Auto-Control system.

stalled on the new RE400-1 six-channel REAC Recorder (Fig. 5). It automatically records the following data at the beginning of each problem run:

a. Mechanical pen zero for each channel.
b. Electrical offset for each channel.
c. Attenuation setting for each channel.
d. Paper speed.
e. In addition, numerical run designation in Arabic numerals is available as an optional accessory.

Running a computer on a tight time schedule means turning from one problem to the next with a minimum of lost motion. Hence accurate recording of all calibration data on the recorder, without possibility of operator error, is most welcome.

Automatic Control Features

Auto-Control System*

The Auto-Control system provides a central operating center for operating the computer—corresponding to tape input programming of a digital machine. Pot settings and complete computer programs can be fed into the computer from an automatic typewriter or tape reader (Fig. 6). The entire computer setup can be read out to tape and then recorded, so the computer can be restored to its former condition merely by running the tape through again. (It should be mentioned that simpler servo-set potentiometer systems and automatic read-out systems are also available which perform some of the functions of this complete Auto-Control system.)

Also originally designed for the new WADC analog computer center, this system is the first commercially-built central-station automatic computer-control system for analog computers. (By the time this article appears, there will be installations operating in at least four computer centers in this country.)

*Trademark Reeves Instrument Company

The console of this system is the nerve center of the computer. The time is approaching when the operator can sit at a desk and deal with the analog computer in terms of diagram symbols through the medium of a typewriter, instead of moving around the computer room dealing with individual computer elements, setting pots, reading dials, and pushing buttons.

Typed or Tape Commands

Through electric typewriter and tape control in the central console, the operator can do any of the following, either by typing out an individual command or by feeding a pre-punched tape into the tape rader:

a. Set any servo-set scale-factor potentiometer to any desired setting.

b. Read the setting of all scale-factor potentiometers, whether hand or servo-set, under actual load.

c. Measure the actual voltage on any scale-factor potentiometer at any point in the problem run.

d. Set any problem-check potentiometer under load to any desired plus or minus initial condition.

e. Read out the setting of any problem-check potentiometer, including polarity.

f. Measure the voltage on any amplifier output.

g. Measure the voltage at any selected points in the computer, such as externals, DFG outputs, resolver outputs, etc.

h. Throw the computer into any one of the four modes (Balance Check, Hold, Reset, Operate).

i. Program the computer automatically, in conjunction with function relays operating as functions of time or any particular variable.

Automatic Cycling

In addition, the Auto-Control system automatically performs a number of cyclic operations which have to be done over and over again in operating the computer. For example, a complete problem check involves reading out all amplifiers and all integrators. Similarly, at the end of the computer day, it is desirable

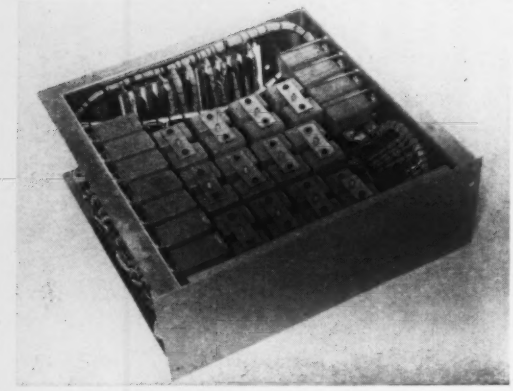

FIG. 7. TYPICAL CODER-DECODER chassis for the Auto-Control system.

to read out all current potentiometer settings onto tape so that they can be re-inserted easily and quickly into the computer at the beginning of the next day.

By pushing the appropriate button, the cyclers will "autocycle," or automatically perform any of the following sequences:

a. Measure (in sequence) all amplifier output voltages and read all potentiometer settings.

b. Measure all amplifier outputs.

c. Measure all integrator outputs.

d. Read out the settings of all scale-factor potentiometers (onto tape, if desired).

e. Read the plus or minus settings of all problem-check potentiometers (onto tape, if desired).

f. Set all servo-set scale-factor pots to zero so that after subsequent setting those actually in use may be easily recognized. A code has been adopted for the system to make it easy to use. For example the command:

rsu 23d/

instructs the machine to read the output of summer 23 in group d. The voltage will be read to 4 significant digits and typed out, with appropriate plus or minus signs and decimal point after the "/" symbol, which is the command for the system to execute the given instruction. Fig. 7 shows a coder-decoder chassis.

The possible ambiguity between the reading out of the setting of a potentiometer and the actual voltage which may be present on the arm during the running of a problem is eliminated by use of "read" for the setting and "measure" for the voltage on the arm during the problem.

For example:

rpt 24a/

instructs the machine to read out the *setting* of potentiometer 24 in a group a—under load—but with the high end connected to +100 volts. The command

mpt 24a/

will record the voltage on the potentiometer arm under actual problem conditions.

To *set* a scale-factor potentiometer, a command is used of the form

spt 24a 1234/

After this command has been typed, or inserted by tape, the "/" will put the computer into balance check, disconnect the high side of the clutch so that the servo can drive potentiometer 24 in group "a" to the value of 0.1234. Fig. 8 shows a servo-set pot package. After the servo has reached a null, the servo clutch is disengaged and the read-back mechanism is energized. This types back in red, along-side the command, the voltage actually set on the potentiometer.

This self-checking feature of the Auto-Control system is important. Servo-set potentiometers are not visible, and a completely independent read-back of the *actual* potentiometer setting detects any errors in the pot setting.

If a number of pot settings are being inserted, it is not necessary to repeat the command "spt" every time. A "repeat" button on the control panel automatically repeats the last coded command, making necessary typing only the identification of the potentiometer and desired setting.

A special "diddle pot" is provided on the Auto-Control panel to set potentiometers manually. This control can be coupled to any pot in the computer by typing in the identification number of that pot. The pot then can be adjusted in any increments desired, retaining all the advantages of the "feel" of manual adjustment.

The automatic read-out cycling features of the system are important to the user. Where a large number of elements is to be read out, a system of individual commands, or even group commands given by tape, would be extremely cumbersome. The Auto-cycle modes make it possible to read out whole classes of elements automatically onto either hard copy or tape.

Automatic programming also opens up other interesting time-saving possibilities. For problems where a whole series of problem runs must be taken with different values of problem parameters, multiple runs can be programmed in advance and run off in minimum time. The computer will automatically make one run, change the proper parameters, make another run etc., until the entire series is completed.

Auto-set Diode Function Generators

The REAC Auto-set diode function generator is designed to operate as an integral part of the Auto-Control system. It operates from the same electric typewriter control and coder-decoder circuitry, thus minimizing the cost of including servo-set function generation in proposed installation.

The system operates as follows:

1. The operator analyzes the function in advance, breaking it down into straight-line segments in normal fashion.

2. The coordinates of the function at successive break points are typed on the electric typewriter.

3. The function generator automatically adjusts itself to produce the desired function.

4. After the function value is set, the control declutches, and the *actual* function value is read back

independently to verify the proper operation of the system.

5. Concurrent with the insertion of function points, a paper tape is punched. This tape may be used at a future date to reset the desired function. As the servo balances the function generator output and not the pot setting, the function may be inserted on any other channel without loss of accuracy.

6. Verification of the entire function, or any segment, can be typed out automatically at any time.

7. As in the manually-set Reeves diode function generators, the break points are brought to the patchbay so that the function generator can be used to generate functions of two or more variables.

Setting up a function on the Auto-set function generator is similar to setting up the ordinary scale-factor pots, except that two coordinates must be typed in for each function point. The operator merely identifies the function generator and the various break points in succession, along with the coordinates of the function at each point.

A typical command would be:

sfgO2e + 1280-8920/

This line will be interpreted by the device as, "Set function generator Oe, breakpoint 2. The X coordinate is plus 12.8, the Y coordinate −89.2." The circuit will adjust the function generator until the *output* is at the correct value, taking into acount the previously set segments, curvature, etc. It then will declutch and read the actual values set back to the electric typewriter, which prints the function generator output beside the command.

The function can be verified at any time at any desired value of X by means of a suitably prepared tape.

Typical Problem Run

Preparation:

1. Formulate the statement of the problem in equation form.

2. Diagram the problem and scale it.

3. Patch up the patchboard.

4. Verify the patchboard connections, using the *patchboard verifier*.

5. Prepare all pot-loading turrets (using the *pot-loading computer* if desired).

6. Calculate the problem-check results.

7. Punch a tape containing the following:
   a. All scale-factor potentiometer settings.
   b. All problem-check potentiometer settings.
   c. Coordinates of all break points in arbitrary functions to be generated by diode function generators.
   d. The complete computer program insofar as it is known at the start, if automatic programming is to be used.

All these functions are performed away from the computer while the computer is running another problem. After patchboard verification, a tape run to verify it, and cross-checking of hard copy against desired pot-settings, the problem is now ready to go to the computer.

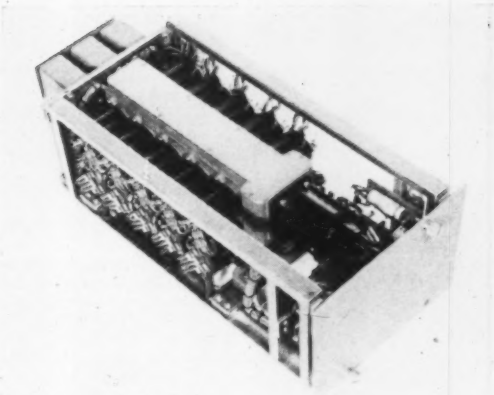

FIG. 8. SERVO-SET POT PACKAGE. Individual pots are readily removable for replacement purposes.

On the Computer

1. Insert patchboard.
2. Plug servo-padding turrets into proper servos.
3. Push the ZS button and zero-set all pots.
4. Insert the tape and read into the machine all the scale-factor and problem-check pot settings. Check the actual readings against the commands to make sure they are being set properly.
5. Insert the function tape and read into the machine all the coordinates of break points in the functions to be generated on the diode function generator.
6. Press the "Problem Check" button.
7. Press Auto-cycle "amplifiers" button to read out all amplifiers. Compare with previously-calculated problem-check values.
8. Put computer into "Problem Check Dynamic."
9. Press Auto-cycle "Integrators" button to read out all integrators. Readings should be 2 (or 10) times previously-read values.
10. Put problem on 6-channel recorder and run problem through once.
11. Throw time-scale switch to half-speed position, and recorder to half previous speed, and run problem again. If two plots do not exactly superimpose, time scaling is wrong. (Check minimum-excursion indicator lights to make sure that voltage scaling is correct in critical spots.)
12. After everything is checked out, throw the computer into "operate" and proceed with the problem run.
13. To remove a problem from the machine for later re-insertion, the potentiometer settings first should be read out onto tape, so that they may be easily restored at a later time. Also run a final problem check, to assure that problem set-up and computer are not changed when the problem is re-inserted.

One of the most important corollary advantages of this centralized computer control is that a complete record of the problem run is preserved by the typewriter. Taken with the automatic recording of recorder calibration data, this eliminates a major source of difficulty in interpretation of problem results.

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WON'T BECOME TACKY or stick to conduit walls, even when overheated.

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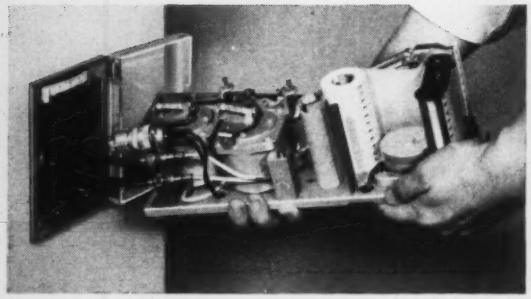
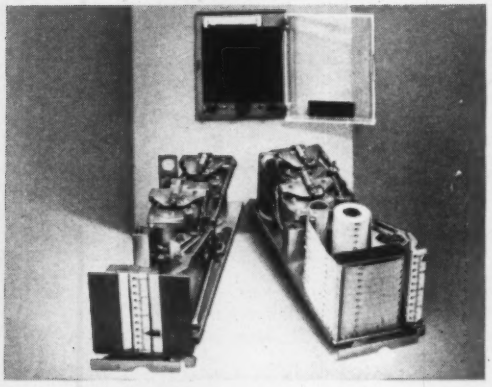
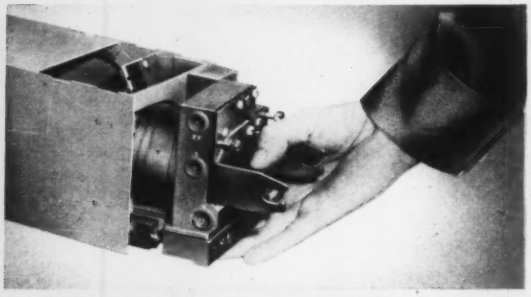


Easily Serviced—All parts can be inspected during operation, without process interruption. To remove chassis completely, unscrew three finger-tight, self-sealing connections.

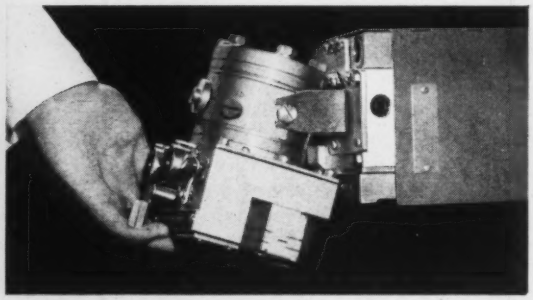


Interchangeable Chassis—Change recorder to indicator or vice versa without interrupting control. Simply pull out chassis, slide another in place.

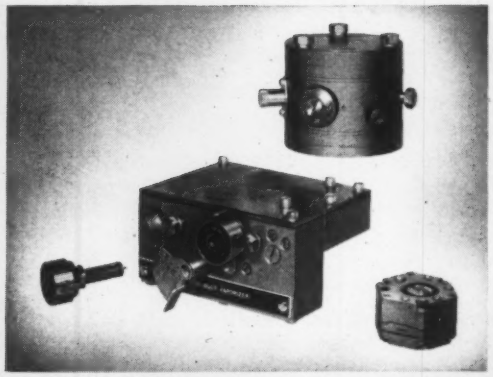


Removable Regulator—Pneumatic assembly, consisting of regulator and switches, can be removed from rear of case without disturbing electrical connections—no need for an electrician to stand by.

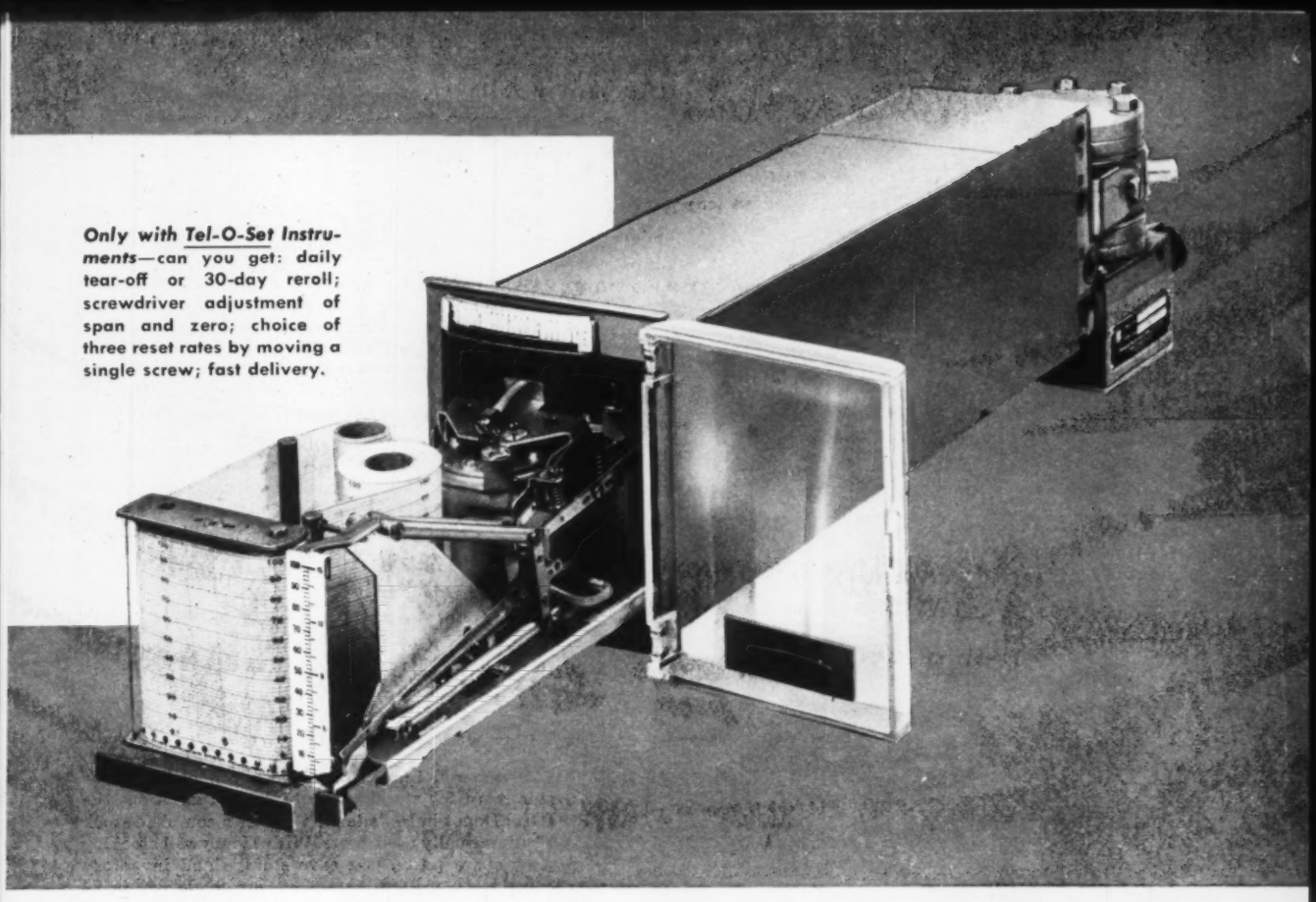
Now you can gain ... *Extra*



Quick-connect Mounting—Controllers have quick-connect switch permitting removal of the unit while process remains on manual control.



Easily Disassembled—Unitized construction of all controller components simplifies maintenance . . . makes reassembly foolproof. No need to dismantle stack to clean pilot assembly.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Savings with TEL-O-SET*

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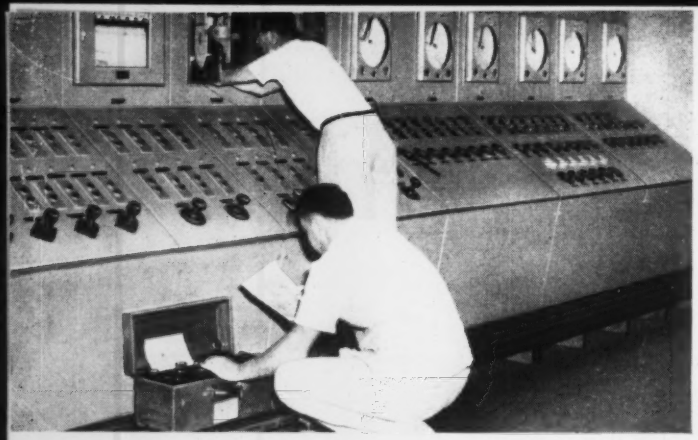

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You can arrange to have a Honeywell service engineer visit your plant at regular intervals to inspect, clean, and adjust your instruments and controls. He's factory-trained and field-experienced in keeping good instruments in top operating condition. If an emergency should arise, a phone call will bring a Honeywell service engineer to your plant in a hurry.

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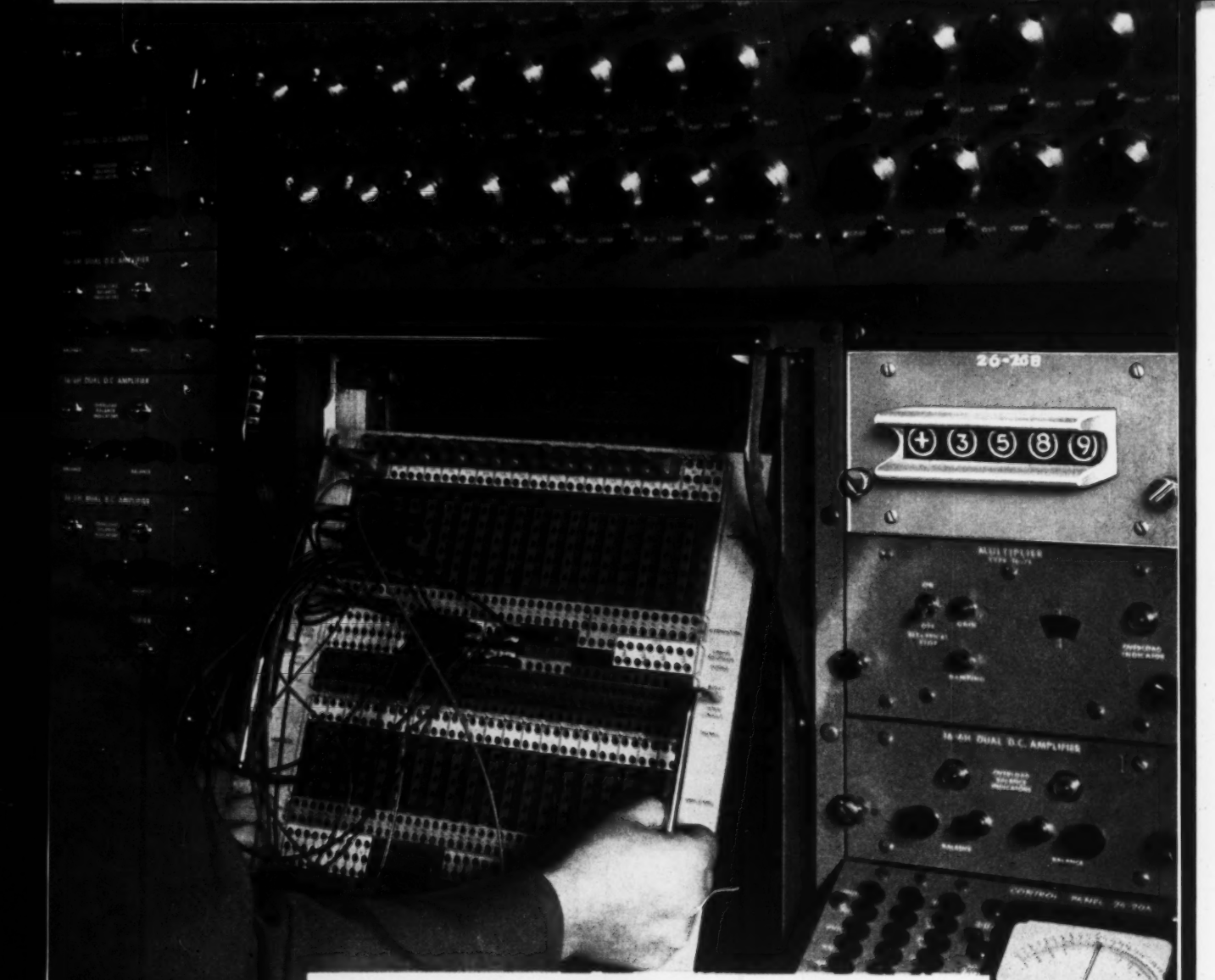

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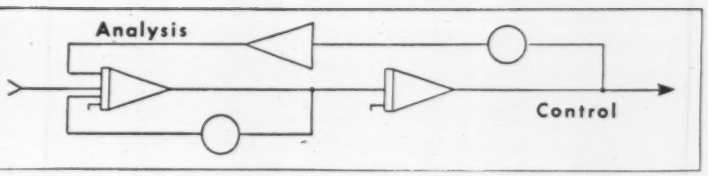
The SIMULATION COUNCIL Newsletter



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Bits

There ain't no justice!

We haven't had much info about the Midwestern Council lately because *Bob Lowry*, their Secretary, was in the hospital last October-November. Then shortly after getting out of the hospital he broke his leg.*

Bob's misfortune prevented his reporting the 3 October meeting of the Midwestern Simulation Council in Chicago, where Tammen and Dennison, Engineering Consultants, were host. I am told that *Hugh Harrington* (Missile Engineering Div., McDonnell Aircraft Corp., St. Louis, Mo.) gave an excellent paper on analog simulation of single and dual-stage electro-hydraulic valves. This was followed by a talk by *Gerhard Reethof* (Vickers, Inc., Detroit, Mich.) on the simulation of hydraulic systems in which, I understand, he advanced some rather unorthodox thoughts that precipitated a spirited discussion. Wish I could have been there.

Anyway, as though to make up for lost time Bob has just sent me an excellent (and heroically impartial) 12-page report of their February meeting which I have been forced to cut somewhat because (1) the same subject has been previously reported (*Newsletter*, December 1956 *I&A*), and (2) we have a meeting of the Southeastern Simulation Council to report.

Ain't justice, but it's necessary!

*Understand he slipped on some ice. Sure glad we live where the only ice we have contact with is under control in drinks!

Pieces

CENTRAL AND MIDWESTERN S/C MEETING OF 11 FEB. ON "PROBLEM CHECKING"

The McDonnell Aircraft Corporation in Saint Louis was host to a joint meeting of the Central and Midwestern Simulation Councils on February 11th.

Jim Pierce (Central SC) graciously relinquished chairmanship of the joint meeting on the subject "Computer Features as Aids to Problem Checking" to *A. C. Robinson* (Midwestern SC) for the technical session.

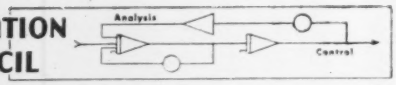
Harris on REAC Techniques

The first speaker was *Holt Harris* (Reeves Instrument Corp., New York, N. Y.), who divided the Reeves checking systems into categories of problem check, time-scale check, voltage-scale check, patchbay verifiers, and REAC auto-control system.

In the problem-check system each integrator output is replaced by a problem-check potentiometer. These are set so that the rest of the circuit is fed the correct voltages. Integrators are simultaneously converted to summers so that their inputs can be checked. A special feature is that fictitious or assumed initial conditions can be inserted without disturbing the problem setup. A *dynamic mode* checks integrator operation and time constants separately. The check operates from the problem equations and verifies the diagramming of the problem, the patching, setting of all potentiometers and function generators, and operation of all computer components used in the problem.

The *time-scale check* slows the problem to half speed. If the solu-

Circle 73 on inquiry card.



tion is the same for both normal and half-speed it indicates that no errors are being introduced by the frequency characteristics of any components.

The *voltage-scale check* monitors voltages at critical points in the problem and lights indicate if the scaling needs readjustment.

The *patchbay verifier* prints in code the identification of each computer element used and the element to which it is connected.

Holt then described the REAC auto-control system with respect to its checking features and use in conjunction with the other checking systems (see pages 894-899 for more info on this system).

Meilander on GEDA Analyzer

Will Meilander (Goodyear Aircraft Corp., Akron, Ohio) next described the GEDA A-14 problem-analyzer system as one which determines that:

1. Every patch connection indicated on the setup diagram actually exists and is electrically satisfactory.
2. No unwanted patch connections exist.
3. All equation coefficients are accurately represented in the machine.
4. Every computing element, linear or nonlinear, used in the problem is operating properly.
5. Every amplifier designated as integrator on the setup diagram is actually an integrator, and all others are summers or inverters.
6. Only desired initial conditions are present and all are correct.

This system does not require prior calculations or problem solution of any kind. It is entirely automatic and the operator can obtain a complete printed record of every connection and gain.

The problem-analyzer circuits automatically break all closed computing loops in the machine by disconnecting all computing element outputs from the patch connections on the problem board. After this is done, a precision test voltage is automatically and sequentially substituted for the output of every element in the machine. After each substitution a rapid scan of all computing element outputs is made automatically and the location and magnitude of every output recorded. Thus the operator is provided with a printed "from—to" record complete with scale factor for every entry.

The *dynamic check* is accomplished by inserting a common input to all possible integrators. When the input is removed only actual integrators maintain an output voltage. These voltages are then scanned and the location and output of each integrator is automatically printed.

Other checks provided by the GEDA A-14 system include automatic initial-condition reversal and automatic 10-to-1 *time-scale change*. The latter is intended primarily to speed up the tedious search process required in solving unfamiliar problems. It may also be extended to include 1-to-2 time-scale change to give a choice of "fast," "real," and "slow" time solutions.

Hussey on EASE Checking System

Similarity of computer checking systems is such that *Joe Hussey* (Berkeley Scientific Div., Beckman Instruments, Richmond, Calif.) prefaced his remarks with the comment that Holt Harris had already presented much of his material. However, Joe advised that complete problem check is now standard in the EASE 1132 and that this system confirms patchboard wiring and attenuator settings to all amplifiers, amplifier special feedback networks, all non-linear equipment, and any external transducers used. The checks quickly isolate mistakes in problem mechanization to a specific area. The engineer can confirm a problem mechanization error or the maintenance people can isolate any malfunctioning computing equipment. The digital output-input translator system can automatically scan and record the voltages of computing elements in the static and integrator check condition.

Kennedy on EA Features

Jerry Kennedy represented Electronic Associates at the meeting. He discussed the three problem checks that EA provides for answering the question "Is the computer solving my problem correctly?" The philosophy is to provide an answer with the minimum amount of extra equipment (which can itself be a source of error) in the minimum amount of time.

In general Jerry described EA's mechanization of checks as similar in principle to those previously described. He also told about some peripheral equipment which is available for more elaborate methods of programming, checkout, and control. The actual patching of a problem board may be guided and checked via punched paper tape with the semi-automatic patching system. The ADIOS system (Automatic Digital Input-Output System) provides punched-paper-tape control of all potentiometers as well as the problem checks. In addition it can automatically control computer mode: i.e., pot set, reset, hold, and operate. Prewired patch panels and a universal test rack provide a quick means of predicting, detecting, and correcting component malfunctions.

Irvine Raises Maintenance Question

Norm Irvine (Mid-Century Instrumatic Corp., Los Angeles, Calif.), the last speaker, said that since the previous speakers had covered checking features quite adequately, he would speak from the user's point of view rather than the vendor's. This did not imply, he said, that Mid-Century did not supply these checking features; they have them as fully developed as anyone else and will include them in their computer system for a price.

Certain of these checking features are quite useful and they work, said Norm. The *static check procedures* are good and have been used for some time. The manufacturers are now supplying circuitry to make such checks more convenient and, since this circuitry requires little additional equipment, it usually works quite well. However, he questioned the need for the *integrator check*. It has been his experience that if an integrator works at all it performs properly. The resistor and capacitor values should just be checked on a routine basis.

Norm considers the *time-scale change* the most important because it will tell when operation is within the dynamic range of the equipment. This procedure is fairly simple and requires little equipment; therefore it works. However, Norm had serious reservations regarding the addition of the other systems and procedures which had been described. He believes that additional equipment will begin to separate the engineer from the problem. An engineer, Norm feels, is quite a knob-twister and dial-turner by nature; it is here that he gains his greatest benefit from using an analog computer. Norm believes that the addition of servo- or digitally-set pots, tape units, elaborate patch checking systems, etc., just add that many more components to the system to cause trouble. In Norm's opinion automatic readout or monitoring devices, when they work, can serve as good bookkeeping aids. But they are

comparatively slow, and to use them efficiently you must do considerable planning on the problem layout and setup, with due regard to what computer points you want to monitor. Frequently this isn't known until you have played with the problem for a while. One point Norm wanted to make was: "There's no substitute for a good engineer."

In answer to a question Norm stated that maintenance problems were increased by the large numbers of relays involved in the systems described. He was refuted by all other vendor representatives, the consensus of opinion being that a good checking system provides a check on its own components, including relays, and that over-all maintenance or down time will be reduced since the checking system will quickly locate and pinpoint the source of error.*

SOUTHEASTERN S/C MEETING OF 15 FEB. AT NORTH CAROLINA STATE COLLEGE

The Southeastern Simulation Council held a meeting at Raleigh, North Carolina on February 15, 1957, with 14 organizations represented. The Research Department of North Carolina State College was host at this meeting.

Dave Prince, Chairman of the Southeastern Council, called on *Dr. N. W. Connor* (North Carolina State College), who opened the meeting with a short welcoming address. *Dr. John Cell* (North Carolina State College) said he hoped the meeting would provoke numerous discussions, and then spoke on the following tours planned in connection with the meeting:

1. IBM Digital Computer Facility
2. The Nuclear Reactor
3. Granpa—The Graphical Analysis Computer
4. GEDA—The Goodyear Electronic Differential Analyzer

Tompkins on a Spinner Rocket

Dr. Harry Tompkins (Research Dept., North Carolina State College) was then introduced. Dr. Tompkins spoke on a spinner rocket development problem set up on the Goodyear computer. In this problem a set of differential equations described the motion and flight of spinner rockets. One of the variables of interest had a large dynamic range which produced large errors when the products themselves were small. A technique used to overcome these errors was to stop the solution and make a scale change. To check the validity of this device, an equation with tabulated results (like Bessel's equations) was solved. The errors were reduced, but with no forcing functions or initial conditions a spiral, rather than a point, was obtained which represented an error in the solution. By introducing a small voltage in opposition to the actual error, the spiral was reduced and the overall accuracy of the solutions improved. Several points were checked using an IBM 650 digital computer and the results showed surprising accuracy.

At the conclusion of Dr. Tompkins' talk, *F. H. Stokes* (Lockheed Aircraft Corp., Marietta, Ga.) asked: "How many minutes did the problem run, and how much drift do you believe the amplifiers had?"

Dr. Tompkins replied that the amplifiers drift very little because they have good capacitors and are chopper-stabilized to which *Bob Lowry* (Goodyear Aircraft Corp., Akron, Ohio) said, "Correction please; these amplifiers are commutator-stabilized rather than chopper-stabilized."

Bob then told of a problem concerning xenon buildup in a nuclear reactor after it had been shut down. This problem ran for eight days without appreciable drift.

Dave Prince then questioned Dr. Tompkins and was answered as follows:

Dave: "Did you add any negative damping?"

H. T.: "Yes, a little."

"Did you solve for Q?"

"r is the base variable. Since Q was actually defined in terms of r, Q was really a function of time in the solution."

"Did you have an automatic time-scale changer?"

"We built up equipment to change the scale automatically. We used a diode in a coincidence circuit to produce a pulse which closed the relay for a scale change. The reset button reset the entire system."

"This is analogous to a floating point in a digital machine?"

"Yes."

Hermann on Some Problems at Akron

Dave next introduced *Mr. P. J. Hermann* (Goodyear Aircraft Corp., Akron, Ohio), who spoke about several classes of problems handled at the Goodyear facility in Akron. The largest class by far was guidance problems for missiles. These problems were originally designed without non-linearities, but it was soon found that there are non-linearities which must be taken into account, such as changing air density, wind velocity, over-all systems noise, and time lags. The problems concerned both "open-ended" and "closed-loop" systems.

An interesting problem dealt with the motion of throttle control and effect on the main rotor of a helicopter. Other problems concerned heat-flow equations in air-conditioning systems.

Finally, a new design for the Goodyear "air-ship" was undertaken. This was essentially a conformal mapping problem and involved changing shapes of an airfoil.

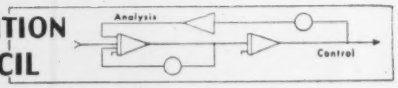
Mr. Hermann's talk was followed by a discussion:

Bill Bradley (Murphy & Cota, Atlanta, Ga.): "Does the computer facility attract outside work?"

PJH: "I am concerned with work on the inside, but the Sales Department has a computer which does work for outside companies."

Bob Lowry: "In the past we have not charged for work done on our

*An interesting question—and one not peculiar to analog computer checking systems. For instance, the RAYDAC at the Naval Air Missile Test Center is a completely self-checking digital computer. Approximately 20% of that computer is involved in the checking function. When you consider that the cost of the computer has been variously estimated at from one to three megabucks, you are talking about a sizeable chunk of dough for checking. Is it worth it? Some users answer an unequivocal "Yes." But there is certainly a point of diminishing returns. Norm would put it low, others higher. An intelligent answer would require consideration of each particular case: What kind of operation are you going to run? How many shifts? What kind of personnel do you have? How much money, etc., etc.



computer by prospective customers; however recently we have had to make a small charge to recover some of the cost."

Bill Bradley: "Are the engineers concerned allowed to set up their own problems on the computer?"

PJH: "Any engineer in the company is invited to use the computer facilities; no exact policy as to how the problem will be worked has been set forth."

Bradley: "How do you allow for transport lead or delay?"

PJH: "We have developed a time-delay circuit."

Dr. Tompkins: "There was a paper by Charles Morrill in the October 1956 *IRE Proceedings* which discussed an operational form of time-delay circuits."

PJH: "Ours is similar."

E. G. Holmes (E. G. Holmes & Assoc., Atlanta, Ga.): "How was noise generated?"

PJH: "We used a bi-state multivibrator to produce pulses which are random in length. These pulses are then passed through a filter to produce voltages of random height."

Mr. D. M. Byck (Electronic Associates) was next speaker.

This space is respectfully dedicated to Mr. Byck, who must be dead. We wrote him two weeks ago for clarification of some mathematical points he expounded in his talk and explained that the world (of *Newsletter* readers anyway) was anxiously awaiting details of his analog computer method for the determination and subsequent use of the weighting function for the solution of differential equations. Surely no living scientist would miss such an opportunity to build professional prestige!

After Mr. Byck's talk the meeting was adjourned for lunch, tours, dinner, and a talk by *Dr. J. H. Lampe*, Dean of North Carolina State, on NC's Honors Program.

Information (Without Theory)

We note with interest that Case Institute of Technology in Cleveland is going to hold two three-week sessions on Process Control Theory this year. The first is 10-28 June and the second 15 July-2 August. Our friends Don Eckman and Irving Lefkowitz, with Lester Goodman, J. F. Sandelien and others will conduct the sessions, which will consist of some 10 lectures, four laboratory periods, and eight discussion periods weekly. "The laboratory exercises include a significant amount of work with analog computers."

AICA

The Association Internationale pour le Calcul Analogique (50, Avenue Franklin D. Roosevelt, Brussels, Belgium), will hold its second Journées Internationales (the first were in 1955) at Strasbourg, France between the 15th and 30th of June, 1958. Also in 1958, in nearby Brussels, there will be a "universal and international exposition," so it should be easy for participants in the Journées to take in the exposition as well.

We are trying to think of reasons why our presence in Strasbourg and Brussels will be essential to the future well-being of simulation!

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Computer Events

Eastern S/C Meeting

Date: Friday, May 24th
Place: Westinghouse Electric Corp., Air Arm Div., Friendship Airport, Baltimore, Maryland.
Subject: "Physical Simulation"
Schedule: 10 AM, Steering Committee; 10 AM, Tour of Facilities; 11 AM, Study Groups; 12 Noon, Lunch; 1 PM, Tech. Sessions.

There will be seven speakers to talk about the physical simulation work being done at Westinghouse Air Arm, AVCO, Bendix, and at Electric Boat Div. of General Dynamics.

The study groups at the meetings will be (1) Physical Simulation, (2) Definition of Fundamentals of Simulation, (3) Combined Analog-Digital Simulation, (4) Future Trends of Simulation, (5) Performance of Analog Computers, (6) Process Simulation. *The process simulation study group will hold its first meeting.*

DDA Council Meeting

Date: Tues. June 11, 1957
Place: Hotel Statler—Ivy Suite, New York City.

Dr. W. J. Schart of Convair, San Diego will lead tutorial session on DDA's; 1400: *Prof. Robert C. Minnick*, Harvard University, will talk on "Design Philosophy for an Advanced Digital Differential Analyzer." Discussion will follow.
AM: Tutorial session 10 AM
PM: Technical discussion 1:30 PM
For information write Stan Rogers, 3023 Alcott St., San Diego, Calif.

Association for Computing Machinery—12th National Meeting

Dates: 19-21 June 1957
Place: University of Houston, Houston, Texas

Symposium on Analog and Digital Computation and System Dynamics

Date: 19-20 November 1957
Places: Wright Air Development Center, Wright-Patterson Air Force Base, Ohio
Subject: There will be one combined session on topics of interest to all groups, followed by separate meetings on digital computation, analog computation and system dynamics. For information write A. C. Robinson, Aeronautical Research Laboratory, WCRRY, Wright Air Development Center.

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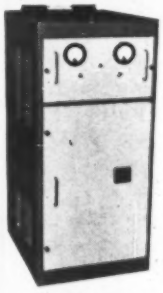

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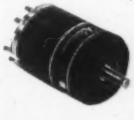

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FIG. 1. E101 COMPUTER is an economical general-purpose digital computer featuring pinboard programming.

You can program this

Caught between the high work cost of manual computation, and high equipment cost for large computers, many engineers and businessmen are turning to the smaller general-purpose electronic machine that permits trial-and-error approaches, easy programming, and rapid program de-bugging. You will know how to program the E101 after reading this article.

JAMES L. ROGERS
ElectroData Div.
Burroughs Corp.

A COMPUTING MACHINE designed to fill the gap between the rotary desk calculator and giant computer would have the following features:

1. The device should be a *general-purpose computer.* It should be capable of solving any problem that can be solved with arithmetic.

2. The computer should be *simple to program.* It should not require a special staff of programmers to set up problems for it.

3. The machine should be *easy to operate.* People who have the problems should be able to run them on the computer. There should be no need for a special staff of operators.

4. The machine should be so built that *it is easy to de-bug a program.* De-bugging represents a significant part of the programming and problem-solving operation; the ease with which a program can be debugged is often a crucial factor in getting the problem done quickly.

5. The machine should *permit the operator to bring his judgement to bear on the solution.* This would make it especially applicable to that large area of problems which require some form of trial-and-error calculation.

6. It should be *small and easy to install,* with modest space, power and cooling requirements.

7. Such a machine should have *low initial cost.*

Fig. 1 shows one answer to this problem, the ElectroData desk-size 101 electronic digital computer. The modified bookkeeping Burroughs machine in the center of the desk is used for *data input and output.* A magnetic drum is used for data storage or *memory* (Fig. 2). Addition and subtraction are performed in the *accumulator;* multiplication and division also use the *B Register.* A novel pinboard device contains the externally-stored program.

The E101 operates in straight decimal system, with no conversion to binary. Nine "spots" on the drum represent one decimal digit.

Memory

The memory unit is a magnetic drum with 100 storage *locations.* The number stored in each location

Presented at the Computer Clinic, Third International Automation Exposition, New York, November 26-30,1956.

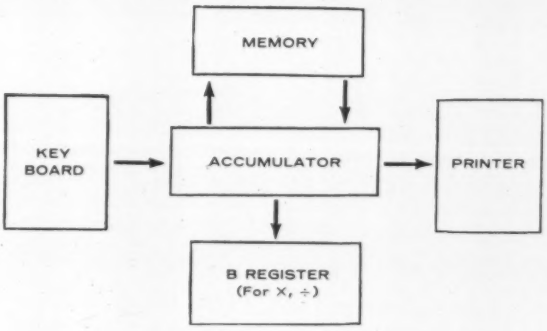

FIG. 2. BLOCK DIAGRAM OF E101. All data enters accumulator via keyboard or optional tape input. Each operation is initiated and sequenced by pinboard program.

Desk-Sized Computer

can be from one to twelve decimal digits in length, plus sign. Each memory location has been assigned a number (or *address* as it is usually called), ranging from 00, 01, 02 . . . up to 99.

Figures that remain constant throughout a problem are stored and automatically picked up from the memory whenever needed. This way the machine can work a problem without operator intervention, and the same figures can be used over and over again without having to enter them into the machine each time they are needed.

The memory is for data storage only; it is not used for computation. The machine instruction for taking a number from the memory and inserting it into the accumulator is **"R".** For example, **R 34** means "Read contents of memory location 34 into accumulator." Similarly, a number can be taken from the accumulator and copied into either the memory or the B Register or the printer by an appropriate command (Table 1).

Things to remember about this data movement are:

1. When you write a number from the accumulator into the memory, the number still remains in the accumulator.
2. The same is true when you transfer a number from the accumulator to the B register.
3. When you read a number from the memory into the accumulator it remains in the memory.
4. If there is already a number in a memory location when you write into it, the old one is automatically erased first.
5. The same is true when you read from the memory into the accumulator; the number previously in the accumulator is erased.

Addition

When you want to add the contents of memory location 78, for example, to the number in the accumulator, this program step would be **+78,** which means *Add number in memory location 78 to number already in the accumulator.* The plus sign tells the E101 what to do, and the number (78) tells it where to find the data.

Subtraction

Any number in the memory can be subtracted from the number in the accumulator by using the instruction "—". For example, **—78** means *subtract number in memory location 78 from number already in accumulator.* The machine keeps track of the signs.

Multiplication

Whenever you multiply (or divide) on the E101, you set up the operation by entering the multiplier (or divisor) in a special register called the "B" register. Once the number is in the accumulator, the instruction **B** then writes that number in the B register.

A number in the B register behaves just like a number in a memory location; it remains unchanged until you write another number over it. It can be used any number of times, and can be changed only by a subsequent **B** instruction.

Table 1—Summary of E101 Instruction
(numbers in parens used for example only)

Instruction	Operation
+(78)	ADD contents of memory location (78) to the contents of the accumulator.
−(78)	SUBTRACT contents of memory location (78) from the contents of the accumulator.
×(78)	MULTIPLY contents of memory location (78) by the contents of the B register; answer is left in the accumulator.
÷(78)	DIVIDE the contents of the accumulator by the number in the B register and store the answer in memory location 78.
R(78)	READ the contents of memory location 78 into the accumulator, leaving the number also in 78.
W(78)	WRITE the contents of the accumulator in memory location (78) leaving the number also in the accumulator.
A 1 (7)	SHIFT LEFT—shift the contents of the accumulator 7 places to the left.
A 2 (7)	SHIFT RIGHT—shift contents of accumulator 7 places to the right.
A 3	ABSOLUTE VALUE—make contents of accumulator positive.
A 4	NEGATIVE OF ABSOLUTE VALUE—make contents of accumulator negative.
A 5	CHANGE SIGN of the number in the accumulator.
A ★	HALT machine.
B	B REGISTER—Transfer contents of accumulator into B register, leaving number also in accumulator.
K	KEYBOARD—Transfer contents of keyboard into accumulator when operator depresses motor bar.
P	PRINT contents of accumulator, leaving copy in accumulator.
U(78)	UNCONDITIONAL TRANSFER—Execute instruction on pinboard 7, step 8.
C(78)	CONDITIONAL TRANSFER—Execute instruction on pinboard 7, step 8, if contents of accumulator are negative; if not, go to next step in program.
S	STEP the internal switch
H	HOME—or advance the internal switch to a give position.
T	TAPE input (data and instructions).
	OTHER instructions are variations of the above.

Table 2—Specifications of the E101

INPUT: 11-column full keyboard of Burroughs bookkeeping machine.

OUTPUT: 2 print cycles per second (24 digits per second); completely flexible format control on rolls or forms up to 18" wide.

NUMBER SYSTEM: Decimal number system; word length of 12 digits (plus sign).

DATA STORAGE: 100-word data storage capacity on magnetic drum; programmed split-register storage.

PROGRAM STORAGE: Program stored by pin settings in 8 removable pinboard units; pins can be dropped through marked holes in paper templates; templates provide permanent program storage; instructions may also be read from optional tape input unit.

PROGRAMMING: Machine language of 29 single-address instructions; 128 program steps; 2 automatic address-modification counters with programmed limits; 1 unconditional and 2 conditional transfer instructions.

SPEED: Addition and subtraction at 20 12-digit numbers per second, multiplication and division at 4 per second (including access times).

OPTIONAL TAPE INPUT: Punched Paper Tape Input Unit reads data and instructions from 5-, 6-, 7-, or 8-channel tape at 20 characters per second.

EXPANDED MEMORY: Expanded Memory provides a total of 220 words of internal data storage. Optional feature.

Once the number is in the B register, it can be multiplied by any number from the memory drum as follows:

×87 means *multiply number in the B register by the number stored in memory location* 87.

The machine holds the product in the *accumulator*, ready for the next operation.

Division

Division is similar to multiplication with two exceptions:

1. Instead of multiplying the contents of some memory location by what is in the B register, you divide the contents of the accumulator by what is in the B register.

2. Your answer appears in the *memory* instead of the accumulator.

Once the divisor is placed in the B register, the dividend is set up in the accumulator by entering from memory, keyboard, etc. The machine instruction for division is: **÷64,** which means—*divide contents of accumulator by number in B register and write the quotient in location* 64. (Note: In case you're wondering what is left in the accumulator after dividing, it's the remainder, which can be divided again, used for round-off purposes, etc.)

Keyboard Entry

The **K** instruction calls for a *Keyboard Entry*—that is, it tells the computer that the operator desires to enter some number (up to 12 decimal digits) into the computer. When the E101 reaches that instruction, it will stop and the Keyboard light will flash (Fig. 3), notifying the operator that the machine is ready for a keyboard entry. The operator then enters the number in the keyboard and touches the motor bar. This not only puts the number into the accumulator, but also prints it on the report so that the operator can check it. (The operator has a choice of four motor bars. Each one moves the typewriter carriage in a different way so as to control the place on the report where the next number is to be printed.)

Once the number is in the accumulator, it can be stored in the memory by use of a **W** instruction. For example, if you want to store a number in memory location 98, you would program the loading as follows:

Step 1: **K**—Enter number into the accumulator when the operator puts it on the keyboard and touches the motor bar.

Step 2: **W98**—Store number now in the accumulator in memory location 98.

When a particular number is going to be used only once in solving a problem, you may want to enter it into the accumulator at the point where it is required instead of storing it in the memory and later reading it out.

Printing

Whenever you want the E101 to print what is in the accumulator, you program in a "P." Next to P you indicate which of the four motor bars you want to do the printing. Just as in the case of a keyboard entry,

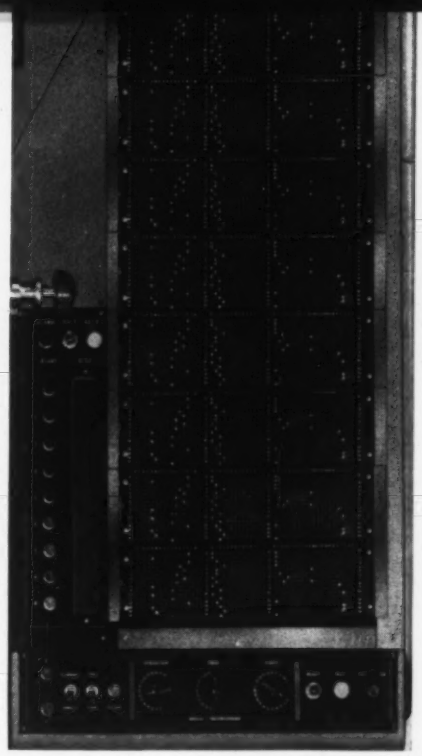

Fig. 3. Control panel and pinboard program. Panel light marked "Keyb'd" lights when K instruction stops computer so that operator can enter a number which starts the computer again.

Fig. 4. Operator reads program sheet and marks machine instructions on paper template.

Fig. 5. Punched template is placed over the pinboard and pins are dropped through the indicated holes.

the choice of motor bar determines where on the report the machine will print. The four printing instructions are: P1, P2, P3, P4. In addition to printing, each of the printing instructions positions the carriage to a different place on the form: P3 tells the machine to print numbers in a vertical column; P2 is used to print across the report horizontally; etc. The report itself can be a tape listing, ledger card, duplication master, or any other document.

Pinboards

Up to this point we have been talking about instructions, but we have not yet described how these instructions are given. The *pinboards* which are used for programming are light-weight frames similar to cribbage boards, containing 16 horizontal rows of small holes. Each horizontal row corresponds to one instruction, making a total of 16 instructions per pinboard.

When programming, write down the machine instructions on an E101 program sheet, mark these instructions on a template which fits on the pinboard, and drop pins in the places indicated. Fig. 4 shows an operator marking the program on the template; in Fig. 5 the template is placed over the pinboard and pins are dropped in the punched-out holes; in Fig. 6 the pinboard is inserted into the E101.

There is room for eight pinboards (Fig. 3) giving a total of 8 x 16, or 128 instructions. The machine

Fig. 6. Assembled pinboard is inserted in the E101. After the problem is solved, the paper template can be removed and filed for future use.

follows each instruction in sequence automatically unless told to do otherwise by *transfer* commands.

Transfers

There are two transfer instructions which tell the machine to go somewhere else instead of to the next instruction. The first is unconditional transfer **U.** If you are in pinboard 2, step 8, for example, and wish to go back to pinboard 1, step 6, you program step 8 of pinboard 2 as follows: **U 1 6.**

The **U** instruction generally provides the method of going from the last step of one pinboard to the first step of the next pinboard. For example, step 15 on pinboard 1 will probably read: **U 2 0** (pinboard 2, step 0) Another place where **U** is frequently used is to repeat part of a program over and over again.

As shown in Table 1, the second transfer instruction is the conditional transfer command **C.**

A Problem

Now that we know the meaning and technique for pinboard programming on the E101, let us solve the following equation for a falling object:

$$S = S_o - \tfrac{1}{2}gt^2$$

where S is the distance from the ground at the end of t seconds of a body falling from an initial height S_o.

As it is probable that you will want to compute S for a number of different values of t, you will save considerable time and reduce the chance of error if you store constant values (like "S_o" and "$\frac{1}{2}$ g") in the memory before you start the problem.

The program instruction would be written:

Step	*Meaning*
1. K	Enter S_o in keyboard (for example, 4730.742 feet) and then operate motor bar. This puts S_o in the accumulator.
2. W 98	Store S_o in memory location 98.
3. K	Enter $\frac{1}{2}$ g in memory location 99.
4. W 99	Store $\frac{1}{2}$ g in memory location 99.
5. K	Enter t in keyboard and touch motor bar. This puts t in the accumulator.
6. W 90	Write t (it also remains in accumulator) in memory location 90.
7. B	Transfer t from accumulator to the B register (prerequisite for multiplying); t remains also in accumulator.
8. x 90	Squaring t; t in B register is multiplied by t from memory location 90; t^2 is now in accumulator.
9. x 99	Multiply t^2 by number stored in memory location 99 ($\frac{1}{2}$g).
10. W 97	Write answer (from accumulator) in memory location 97.
11. R 98	Read contents of memory location 98 (S_o) into accumulator.
12. — 97	Subtract $\frac{1}{2}gt^2$ (in memory location 97) from S_o (in accumulator).
13. P	Print contents of accumulator ($S_o - \frac{1}{2}gt^2$) on report.

The problem has been programmed for one value of t. To compute S for a series of values of t, only one more step is necessary. The transfer instruction, **U**, can tell the E101 to go back to the beginning of the problem to await keyboard entry of another value of t, as follows:

14. U 15 Go back to step 5, pinboard 1; enter new value of t in keyboard, and repeat problem automatically.

The pinboard program for the above instructions is shown in Fig. 7. This problem illustrates only a few of the E101 abilities. More complex situations require use of additional features, as follows:

Changing Contents of Accumulator

We have already seen that we can change the contents of the accumulator by any of the following operations: add (+), subtract (—), multiply (x), divided (÷), read (**R**) or keyboard entry (**K**).

The contents of the accumulator can be altered also by programming an A (meaning "Alter Accumulator") and indicating how contents should be altered. A is used as follows:

A 14—Shift contents of accumulator 4 places to the left (same as multiplying by 10^4).
A 24—Shift contents of accumulator 4 places to the right (same as dividing by 10^4).

Of course, 4 is used only as an example. You can shift the contents of the accumulator anywhere from 1 to 10 places. These two instructions are sometimes called *decimal shift* instructions and are used most often to keep the decimal point of answers in the proper position for print-out, etc.

The other three A instructions that alter the accumulator are the "absolute value" instruction (Table 1):

A 3—Make contents of accumulator positive.
A 4—Make contents of accumulator negative.
A 5—Change the sign of the number in the accumulator.

Operator Override

Even though the machine computes and prints completely automatically, you can program in an instruction that will halt the machine at a strategic point in the problem. The operator then can use his judgement to alter the course of the solution of the problem.

The halt instruction is written as:

A ★

When the operator is ready for the E101 to continue with the problem, he merely touches one of nine START buttons, depending on what he wants the E101 to do next (Fig. 3).

De-Bugging

A toggle switch permits the operator to change the machine from pinboard control to control by manual switch setting. These switches can be set up to perform any one of the machine's operations, and they permit the programmer to check out the program himself, printing out an operation-by-operation check on the calculations. The switches permit examination or

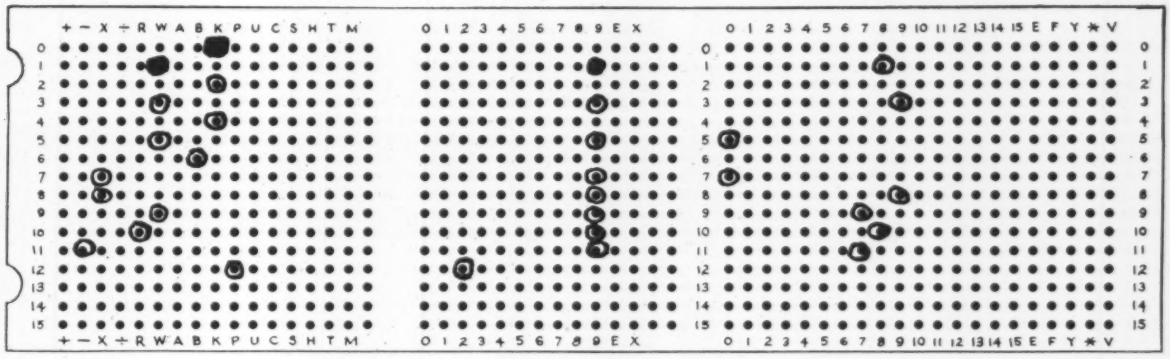

Fig. 7. Paper template marked for sample problem.

change of the contents of any memory location without disturbing the pinboard settings. The visible, alterable program, and the convenience with which any or all operations can be monitored, make de-bugging simple and fast.

Stepping

Sometimes you may want to modify part of the program each time you repeat it. For example, let's assume you have ten constants which you want to load in memory locations 90 to 99 for later use. You can program the loading in this way:

Step	P.B.1	Step	P.B.1	Step	P.B.2
0.	K	8.	K	0.	W 97
1.	W 90	9.	W 94	1.	K
2.	K	10.	K	2.	W 98
3.	W 91	11.	W 95	3.	K
4.	K	12.	K	4.	W 99
5.	W 92	13.	W 96		
6.	K	14.	K		
7.	W 93	15.	U 20		

You are repeating the same two steps of your program (**K** and **W**) over and over again. In each case you are modifying the **W** instruction slightly by writing first into memory location 90, then into 91, etc. You can make use of the **U** instruction to save program space by using an automatic internal switch called the *F switch*. This switch makes it possible to change the second digit of the memory location each time the routine is repeated.

The first thing is to set the F switch at zero, or "Home the F switch." Write this instruction:

H 10—Home the F switch to zero.

In order to change the second digit of the memory location each time the routine is repeated, pin an F for the second digit, and then advance the value of the F switch once each time. Use the S instruction for this purpose. It is written as follows:

S 19—Step the F switch to the next value each time the E101 comes to this part of the program.

Do this until the F switch steps past 9.

Using the H, S, and U instructions, you can now write the program in five steps:

Step	P.B. 1	Meaning
0.	H 1 0	Home the F switch to zero.
1.	K	Enter constant on keyboard and write it into accumulator.
2.	W 9 F	Store constant in memory location 9F, where F is whatever position the F switch is in. The first time it would be 0, then 1, etc.
3.	S 1 9	Step the F switch one step each time this instruction is executed until the F switch steps past 9.
4.	U 1 1	Go back to instruction 1 and repeat routine.

In addition to the F switch, there is an *E switch* which generally is used to change the first digit of the memory location instead of the second. As most problems require more than ten memory locations, both switches are frequently used.

Conditional Transfer

Conditional transfer is referred to as "**C.**" Like **U**, it tells the E101 to go to another instruction. However, it tells the machine to go there only on one condition—if the number in the accumulator is negative.

This instruction is useful where numbers must be compared, such as in preparing weekly payrolls.

Punched-Tape Input

An optional punched-tape input unit can be used to read both instructions and data from 5-, 6-, 7-, or 8-channel punched paper tape. It can be used to by-pass the keyboard for rapid, accurate entry of data.

Conclusion

When there are many problems that have subroutines (such as square root, trigonometric functions, etc.) there is no need for programming these subroutines each time they occur. Instead, you program them once and then use the appropriate programs whenever necessary. A library of these subroutines which already have been programmed is available to E101 users.

Journal of the S C M A . . .

SOUTHERN CALIFORNIA METER ASSOCIATION

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EXPANSIBLE-TUBE VALVES

FOREST H. WEHRMAN
Grove Valve & Regulator Co.

1. **The Flexflo is a simple and rugged gas regulator.**
2. **It may be pilot or self-operated.**
3. **It closes tightly over small particles of foreign material.**
4. **It has a high rangeability.**
5. **It is less noisy than conventional regulators.**
6. **It operates freely after long periods of inaction; its only moving part, the expansible tube, is always ready for action.**

June Meeting: *Monday, the 17th.*
Feature: *Field Trip to Southern California Gas Company Compressor Plant, Playa Del Rey, Calif.*

EXPANSIBLE-TUBE-TYPE VALVES and regulators were introduced about fifteen years ago, and have been increasingly used by gas companies and other services. They are commonly known as the "Flexflo."

The Flexflo valve (Fig. 1) is a simple and rugged

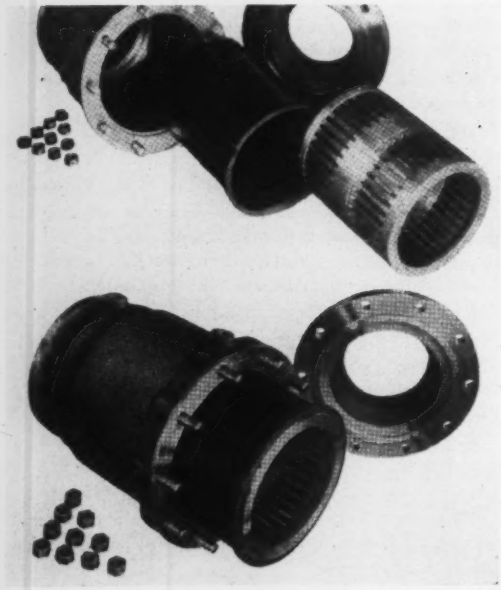


FIG. 1. THE EXPANSIBLE-TUBE FLEXFLO valve, disassembled (top) and assembled (bottom)

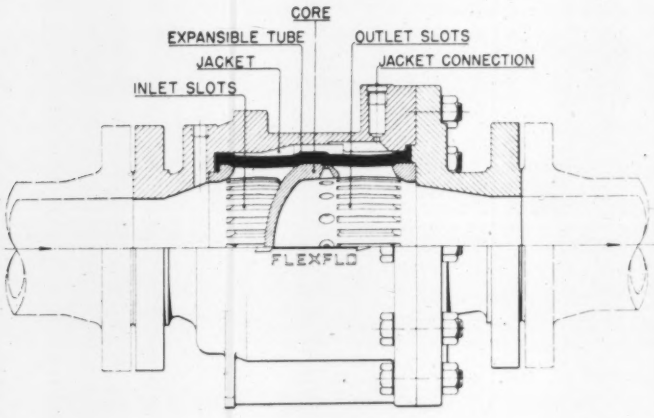


FIG. 2. ELEMENTS of the expansible-tube valve.

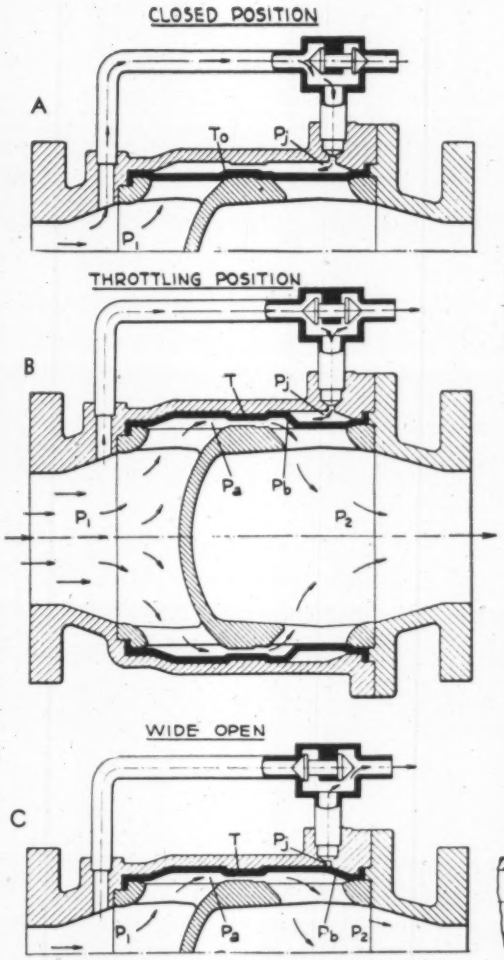


FIG. 3. PILOT CONTROLS position of expansible tube.

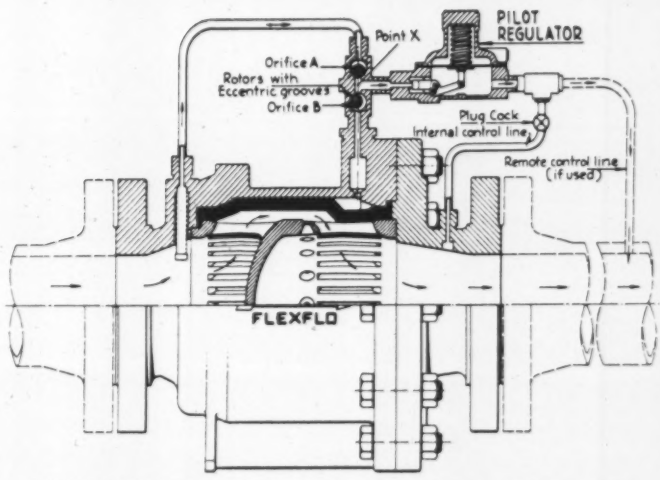


FIG. 4. USE WITH diaphragm-operated 3-way pilot for regulating service.

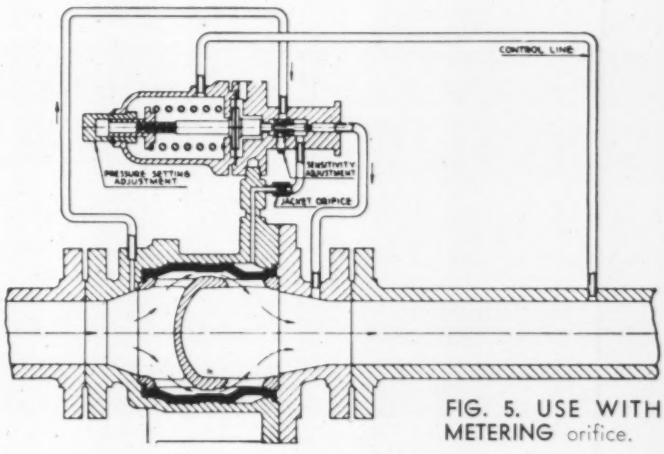


FIG. 5. USE WITH METERING orifice.

unit with only a single moving part—the expansible tube, which acts as both inner valve and operating diaphragm. This tube not only lasts longer than conventional hard- or soft-seat valves, but it is easier to inspect or replace. As with any regulator, it should be inspected at periodic intervals.

The Flexflo is a pilot-control-type regulator. No auxiliary operating medium is required. The line pressure is applied directly to the rubber tube which acts as the operating diaphragm. It is a "fail-open" regulator.

Operation

Fig. 2 shows the components of the valve, and Fig. 3 shows the valve in the closed, the throttling, and the wide-open position. A simple three-way valve is shown to illustrate the pilot.

In Fig. 3A the Flexflo is tightly closed because the three-way valve is positioned to introduce the full inlet pressure on top of the jacket. The pressure acting on the underside of the jacket is less because of the slight pressure drop produced by the inlet shots. Thus the downward force (line pressure times the entire area of jacket) is much greater than the upward force and the sleeve seats tightly against the core.

Fig. 3B shows the Flexflo in a throttling position. As the three-way valve is now positioned to reduce the jacket pressure, the effective jacket pressure is reduced and the jacket permits flow through the core.

Fig. 3C shows the Flexflo in a wide-open position. The three-way valve is now positioned to close off the inlet pressure to the jacket. The line pressure now forces the valve wide open.

The Flexflo is manufactured in sizes 1" through 12" in four basic pressure ranges from 200 psig to 1500 psig maximum cwp.

Pilots

Several pilots are available. The Grove Model 820 pilot (Fig. 4) is a three-way, diaphragm-operated, spring-controlled pilot which senses pressure changes in the downstream system and automatically positions the three-way valve in accordance with system demand and pressure. Other pilots are available to make the Flexflo a pressure-relief valve, a diaphragm motor valve, a liquid-level controller, a flow-rate controller, etc. Some of these utilize a simple pressure-reducing or relief valve and metering orifice, in place of the three-way valve (Fig. 5).

Applications

The Flexflo is used widely for reducing transmission pressures down to, say, 150 or 300 psig, and also in gas distribution and pressure reduction under 100 psig to 5, 25 or 35 psi.

The unique design of the Flexflo lends itself to unusual application. The pilot system is basically simple. All that is required is a restricting or metering orifice and a variable orifice. This variable orifice may be a house-service pressure regulator, it may be a small, standard self-contained pressure regulator, or it may be a diaphragm motor valve (DMV). In the latter case the DMV may be controlled by a pressure or flow controller. In the case of a remote-set flow controller it may be desirable to have an automatic over-pressure feature; it is only necessary to install a pressure regulator in the line, downstream of the DMV. This pressure regulator will close when the reduced pressure exceeds its setting. When this line is closed, the Flexflo will close. As it is only necessary to reduce the jacket pressure slightly below the tube expanding pressure to open the Flexflo, the size of the metering orific and its relation to the DMV size is not critical. The valve also can be used with small downstream capacities in relation to flow, hence is stable on applications in power plants and other applications where the minimum flow may be small compared to maximum flow.

Installations are in service handling a minimum flow of 100 MCFH where the wide open flow of the regulator is 5,000 MCFH. This would not be particularly tough if the downstream system were large and the flow changes gradual, but when the downstream system is small and the flow changes rapid and drastic, the pressure regulation problem becomes complex.

Over-Pressure Monitors

Methods of protecting a system from over-pressure are being widely discussed. In general, three methods are used—(1) relief valves or valves adequate to handle the entire capacity of the regulators feeding into the system, (2) safety shutoff designed to either shut off the district regulator or another regulator in the same line in event of abnormally high pressure, or (3) "monitoring" with a secondary regulator installed upstream of the existing regulator. This "monitor regulator" is set at a higher pressure than the existing regulator, and as it takes its control point downstream of the existing regulator it is wide open in normal service. However, should the pressure regulator fail wide open or stick in position to pass more than system load, the "monitor regulator" will automatically come into service and control the system pressure at only a slightly higher pressure than normal.

A large number of monitor regulators have been installed in the distribution system of a utility company in Southern California. The line pressure is 60 psig in most cases, but in some cases goes to 250 psig. The system pressure is controlled at 8″ w.c. The "Monitor Regulator" is set at 12″ w.c. A 2″ "monitor regulator" was chosen because it would handle maximum flows with 1.5-psi pressure drop. This, of course, did not affect the capacity of the existing regulator. The Flexflo was chosen because of its wide-open capacity, over-all size, and ability to handle dust, dirt and pipe scale without deleterious affect on the tube.

This same method has been used on high-pressure distribution systems. In some cases the "monitor regulator" has been installed in the same vault as the pressure regulator; however, the general practice is to install the "monitor" in a separate vault, separated from the regulator by distances up to 50 ft.

Relief Valves

The Flexflo has been used widely as a "safety" or "stack" relief valve. It shuts off "bubble-tight." Contrary to many metal-seat relief valves, it shuts off bubble-tight again after it has opened. It can never "fail closed."

Booster

The Flexflo has been used with a special pilot to accomplish pressure boosting—that is, boosting the reduced pressure with increased flow at a predetermined rate so as to compensate for line losses in the downstream system. A number of installations are successfully handling various systems, some as much as 30 miles long.

Rangeability

The Flexflo offers high rangeability—that is, ability to handle a wide range of minimum to maximum flows. In the past, when flows varied greater than 50 to 1 it has been necessary to use two regulators, one larger and one smaller. A 6″ Flexflo is handling flows at 10,000 CFH minimum and 3,500,000 CFH maximum with an inlet pressure of 250-400 psig and a reduced pressure of 130 psig. The Flexflo can handle a low flow and also a future higher flow if load increase is anticipated.

Noise

Two factors combine to make the Flexflo comparatively quiet in operation—(1) the flexible tube acts as an insulator and (2) the direction of flow is changed only 30°. Contrary to conventional regulators, where the highest noise intensity is in the regulator body, the highest noise intensity on a station using a Flexflo regulator is about three pipe-diameters downstream. This means that it is easy to insulate or bury the downstream piping to reduce noise.

Freezing

When natural gas contains water vapor, even in small quantities, and the temperature is reduced either because of low ambient temperature or pressure reduction (about 6° F drop per 100-psi drop), hydrates form and a freeze-off can occur. This can occur in the regulator, upstream, downstream, or in the line itself. Owing to the pilot system used on the Flexflo, the lowest pressure in the pilot system is the reduced pressure being maintained; hence it is less likely to freeze. Also, the flow pattern through the Flexflo causes a less drastic change in direction of gas flow and, therefore, the Flexflo may not freeze in some places where conventional regulators have frozen. Of course the final answer to freezing is either dehydrate the gas or add heat in any of the various methods being used.

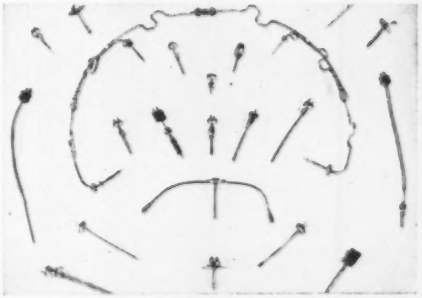
Only high-quality tubing can protect sensitive thermocouples in heat like this

—that's why the manufacturer uses Superior tubing

From Thermo Electric Co., Inc., maker of aircraft and industrial thermocouples, come orders for tubing to withstand temperatures from —300° to above 2200°F, with high scaling resistance at that fierce heat—with high shock, fatigue and corrosion resistance—produced to unusually close tolerances and with spotlessly clean, smooth inner diameter. The tubing they order is in a wide variety of sizes and analyses, including Inconel, "A" Nickel,[1] Monel,[1] Nichrome "V",[2] Chromel "P",[3] and a number of stainless steel analyses.

Since the first order was filled 14 years ago, Thermo Electric has become another of the many steady, satisfied Superior customers. Superior tubing is giving them long, reliable service in precision-made thermocouples for virtually every industrial need, from jet engines to open fired furnaces.

Superior's reputation is built on its ability to produce small tubing to meet rigid specifications in a broad range of analyses —from stainless, carbon and alloy steels to nickel and nickel alloys, beryllium copper and titanium. Equally important to manufacturers in every industry is the wide range of sizes and shapes available, plus Superior's long experience in producing as standard tubing what other mills class as specialty work. For detailed information on Superior tubing, write for a free copy of Bulletin 40. Superior Tube Company, 1968 Germantown Ave., Norristown, Pa.



The Thermo Electric thermocouples shown above are representative of the wide range made for industries of every kind, and in sizes from a fraction of an inch to over 40 ft. in length.

[1] *Registered trademark International Nickel Co.*
[2] *Registered trademark Driver-Harris Co.*
[3] *Registered trademark Hoskins Mfg. Co.*

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All analyses .010 in. to ⅝ in. OD—certain analyses in light walls up to 2½ in. OD

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EVEN AFTER SHUTTING
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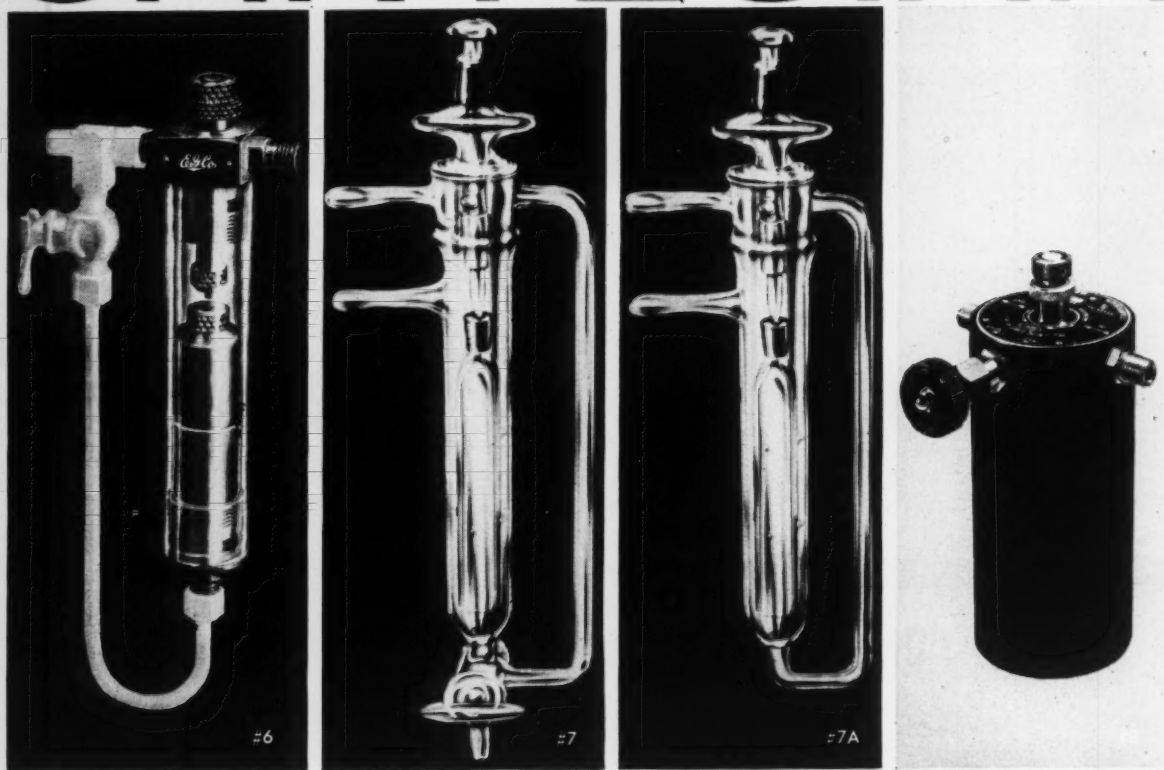

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Exclusive with Emil Greiner! No other instruments in the field can compare with these remarkable Cartesian Manostats for *sensitivity*, *accuracy* and *reliability*. Designed on the simple phenomenon of the Cartesian Diver, their construction, installation and operation is uncomplicated and extremely dependable.

Among these manostats is the one to meet your requirements. They are designed to suit the sensitivities and capacities of the many installations from a simple laboratory distillation at controlled vacuum to large simulated pressure chambers for testing of aviation devices.

For complete information, write for Constant Pressure and Vacuum Control Bulletin.

■ **G15074 Cartesian Manostat No. 6,** all stainless steel, delivered with mercury and directions for use . . . ea. **$60.00**

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The EMIL GREINER Co.

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Why these WESTON PORTABLES excel in

STABILITY... RUGGEDNESS... SHIELDING!

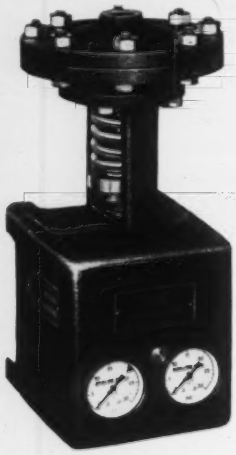
Familiar in external appearance, all these portables are totally *different* inside. The movement employed is the highly stable, shelf-shielded WESTON CORMAG® mechanism. The *difference* is evident, in service, in several ways. The movement is far more rugged... more resistant to vibration and shock ... thus protecting instrument accuracy and dependability over far longer periods. There never need be concern about external magnetic fields, for the yoke design provides a permanent magnetic shield... so efficient that an instrument may be used at a distance of only 15 inches from a conductor carrying 1000 amperes and show an effect of less than 1/10 of 1%. And the instrument is far lighter in weight... more convenient in handling. Complete details on these Weston CORMAG® portables may be obtained from your local Weston representative, or direct from WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey.

A DAYSTROM UNIT

WESTON *Instruments*

For more information circle **77** on inquiry card.

This installation in the De Laval Steam Turbine Company in Trenton, N. J. demonstrates how fast load changes, caused by turbine tests, place a grueling load on this pressure controller reducing station for makeup. In the words of the power plant engineer: "The control stability is good and the controller does the job well."



Leslie Pressure Pilot

Narrow Band Pressure Control *with Stability*

Wide band stability and narrow band proportional control are uniquely combined in the Leslie Control Pilot without need for extra mechanisms to correct for over-sensitivity.

While the pilot responds to small, *definite* pressure changes, it "sorts out" and "ignores" the small, spurious* disturbances common to most control systems. Since it does not follow nor magnify these disturbances, cycling and hunting are eliminated. It is ideal for systems with short lag factors.

*not directly related to process variables but resulting from pipeline friction and turbulence.

NO COSTLY EXTRAS

The "designed-in" stability and high capacity of Leslie Pressure Control Pilots also eliminates costly "extras" . . . there is no need for automatic reset, valve positioners or filter-type air sets. You get stable, reliable control *without* fussy adjustments and with *ordinary* plant air or water for the operating medium.

MORE INFORMATION

Ask your Leslie engineer to give you the complete story of the exclusive features that make Leslie Controllers ideal for straight pressure control problems. He's listed in your classified directory under "valves" or "regulators". Send for bulletin described at left.

Send for Bulletin 5303 that gives complete technical data and typical application sketches for the Leslie Pressure Control Pilot.

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x-y recorders

plus a COMPLETE line of ACCESSORIES!

Every operating convenience possible has been built into these new E-I X-Y Recorders to provide maximum simplicity of control and ease of maintenance.

In addition, numerous performance features such as freedom from jitter, isolated inputs, automatic pen lift, vacuum hold-down, high-performance servos, and sensitivities from 0.5 mv per inch to 50 volts per inch provide performance excellence found in no other recorders.

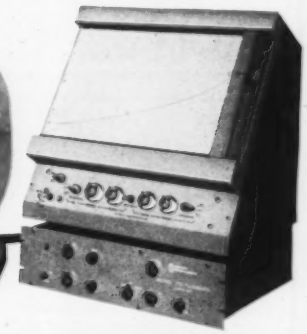
Models are available for general-purpose recording, data handling, and analog computer recording and function generations. Ask your E-I representative for the complete story.

1

model 100

8½ x 11", flatbed, or rack mounted
0.25% accuracy
½-second full scale pen speed
11 scale ranges, 5 mv to 500 v full scale
200,000 ohms-per-volt input impedance

2

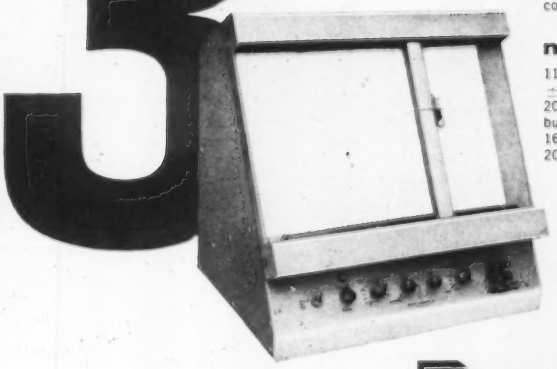


model 200

11 x 17", flatbed
± 0.15% of full scale accuracy
20" per second slewing pen speed
3 scales; 0.1 v, 1.0 v, 10 v per inch
scale and zero potentiometers with in-line dials
1 megohm input resistance

Shown with Keyboard (Model 175) and Symbol Generator (Model 250)
10-key keyboard
six electrically selected characters
complete operational controls

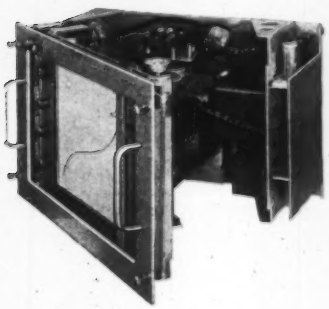
3



model 225

11 x 17", flatbed
± 0.2 full scale accuracy
20" per second slewing pen speed
built-in electronic reference
16 scale ranges, 0.5 mv to 50 v per inch
200,000 ohms-per-volt input impedance

All models available for standard rack mounting. 11 x 17" instruments may be used in standard cabinet or rack mounted — without changing metalwork!



Accessories include: Curve follower (Model 210), Card-Tape Converter (Model 150), Keyboard (Model 175), and Symbol Generator (Model 250).

ELECTRO INSTRUMENTS INC.

3794 Rosecrans Street, San Diego 10, California

For more information circle **79** on inquiry card.

INSTRUMENTS and AUTOMATION

New Instruments

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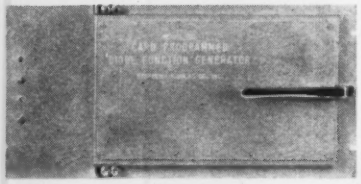
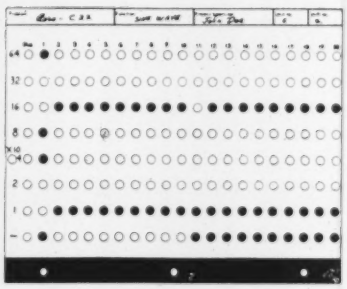
COMPUTING and DATA PROCESSING

CARD PROGRAMMER

New "Model 160 General-purpose Diode Function Generator" reduces analog computer set-up time from





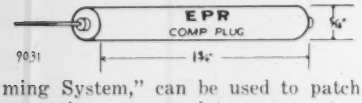
Examples of holes punched to set up a sine wave on generator. Figures reading left to right represent breakpoints; top to bottom figures represent binary values of slopes at breakpoints and sign of slope. Hole at extreme left provides for increasing maximum slope by a factor of 10. Three holes at bottom are for keeping card in 3-ring notebook.

hours to seconds. It utilizes computing amplifiers and junction diodes to generate a function of input voltage. Function consists of 20 continuous line segments, with break points equally spaced at 10-v intervals referred to input voltage. Values of start point of function and of slope at each break point are stored on an 8½" x 11" punched card. Holes in this card actuate sealed switch assemblies to provide circuitry required to generate desired function. Unit is ready to operate when card cover is closed. No moving parts except card access door and sealed switches. Outstanding reliability owing to absence of servos, clutches and usual slide-wire resistors.—*The Stephen-Douglas Co., Inc.*, 1650 21*st St., Santa Monica, Calif.*

For more information circle **301** on inquiry card.

PLUG-IN COMPONENTS

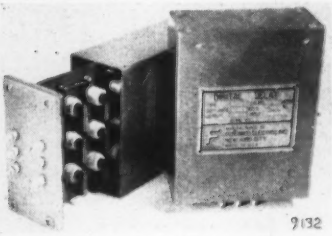
New "Comp-Plug" packages, especially designed for use with new "AMP Shielded Patch Cord Programming System," can be used to patch an entire program into a computer, telemetering equipment or testing equipment. Shown: a precision wire-wound resistor encapsulated in a package measuring about ⅞" x 1¾"; one end terminated in an AMP male pin; other end available as a solder terminal, a female receptacle, or a cable to facilitate patching to other components on board. Diodes, capacitors, RC networks are among components that can be supplied.—*Eastern Precision Resistor Corp., 675 Barbey St., Brooklyn 7, N. Y.*



For more information circle **302** on inquiry card.

LATTICE NETWORKS

New lumped constant electromagnetic networks, specifically developed and designed for digital storage, use

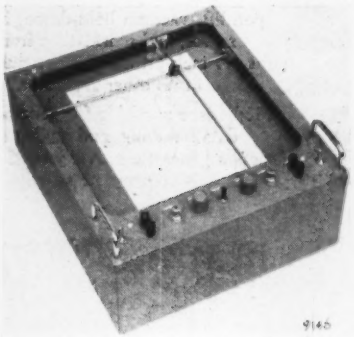


only 1.2 elements per bit, and provide highly stable characteristics without extreme tolerances on individual elements. Hermetically sealed units can be supplied for any capacity up to 30 bits at digit rates up to 5 Mc in operating temperature range of −20°C to 70°C.—*Ferranti Electric, Inc., 30 Rockefeller Plaza, New York 20, N. Y.*

For more information circle **303** on inquiry card.

X-Y RECORDER

New low-cost *X-Y* recorder uses standard 8½" x 11" graph paper for computer readout, hysteresis curves,

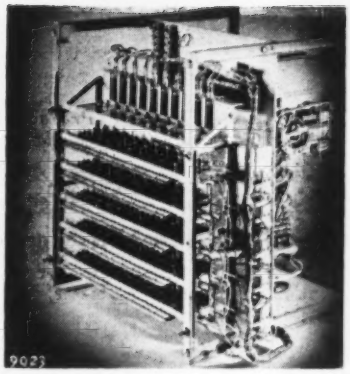


characteristics stress/strain; temperature/pressure, etc. Pen moves on the *X* and *Y* axes in accordance with voltage signals applied at input terminals. Sensitivity 10 mv/in; input resistance 10,000 ohms; power requirement 100 w 115 vac.—*Mandrel Industries, Instrument Div., 5134 Glenmount Drive, Houston, Texas*

For more information circle **304** on inquiry card.

CROSSBAR SCANNER

New "SC1A Crossbar Scanner" is an integrated monitoring device capable of rapid sequential or programmed scanning of data points; functional advantages of maker's "Crossbar Switch": low contact resistance of 0.02 ohm (either gold or palladium contacts available), low thermoelectric potentials of less than 0.01 uv in range 25 to 50°C, high leakage resistance (where necessary units with not less than 10^{12} ohms leakage can be supplied) and excellent HF performance (crosstalk 65

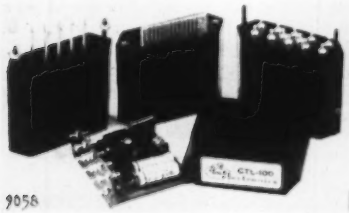


db down at 10 Mc). Illustrated "Model 200SC1A," 200 points arranged in 10 groups of 20 points each, with facilities to automatically skip any group on command, to start at beginning of any group on command, and to automatically stop at end of any group. Scanner utilizes three-dimensional conductor arrangement of maker's "Crossbar Switch," whence a considerable saving in space and cost. —*James Cunningham, Son & Co., Inc., Rochester 8, N. Y.*

For more information circle **305** on inquiry card.

LOGICAL ELEMENTS

New transistor-magnetic-core building blocks use one transistor and one rectangular-hysteresis-loop



magnetic core per element. All logical functions can be economically implemented with these units, owing to their ability to perform logical OR, logical inhibit, and data storage. Features: low power, compactness, versatility, wide operating ranges, and long life. "This is believed to be the most reliable logical element available." Available at two rated operating ranges of 0 to 50,000 and 100,000 bits per second. Normal packing density 120 units per square foot of panel space. Units are available with solder lugs, printed circuit lugs, or plug-in headers, and also custom-packaged.— *Mack Electronics, 40 Leon Street, Boston 15, Mass.*

For more information circle **306** on inquiry card.

TAPE WINDER

New "Model 3055 Tape-File Electric Tape Winder," for taking up either from a tape punch or a reader, can also be fitted to rewind adding machine tapes and is easily adaptable to teletype systems. Entire winding reel can be easily removed from unit

WELCH
20 MICROAMPERES
D. C. PANEL METERS

MODEL NO. 350

• Accuracy 2% of full scale deflection

Welch Model 350 Panel Meters are often used in temporary "bread-board" assemblies and in "homemade" devices so common in electronics laboratories. In such work it is frequently more convenient to have an attached rather than a separate meter.

Suitable for such applications as measuring grid currents and currents from photoelectric tubes and cells. They have alnico magnets, sapphire bearings, and especially selected pivots to make possible the extremely sensitive 20 microampere movement.

MODEL NO. 351

These precision instruments are expertly designed, highly sensitive, sturdily built and adapted for work requiring the most rugged performance.

- Stable and Well-Damped
- Flush Mounting Bakelite Cases
- High Torque Ratio

MODELS

350—3½ inch round—2.4 inch scale
351—3 inch square—2.4 inch scale
451—4½ inch rectangular—3.5 inch scale

MODEL NO. 451

TYPES

Microammeters 0-20 up to 0-500
Milliammeters 0-1 up to 0-500
Ammeters 0-1 up to 0-30
Voltmeters, various ranges, 100 to 50,000 ohms per volt
Zero Center Ammeters
DB Meters
Rectifier Instruments
Thermocouple Meters
Special Scaled Meters

A complete line of round, square, and rectangular meters is manufactured by Welch.

WRITE FOR OUR METER CATALOG

W. M. WELCH SCIENTIFIC COMPANY
DIVISION OF W. M. WELCH MANUFACTURING COMPANY
ESTABLISHED 1880
1515 Sedgwick Street, Dept. B Chicago 10, Illinois, U. S. A.
Manufacturers of Scientific Instruments and Laboratory Apparatus

For more information circle **80** on inquiry card.

If production "pivots" on costs

MODERN, standardized production methods developed by Welton V. Johnson mean better, lower cost instrument pivots, shafts and other precision miniature parts for you.

Quality production methods assure you the finest pivots, shafts, staffs and other miniature special steel parts, all heat treated for maximum hardness and polished to a metallographic finish. Sizes up to $\frac{3}{16}$" diameter.

Write today for complete information on Johnson pivots, samples or specific quotations.

LA 1157

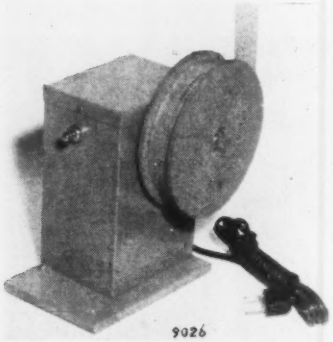
Welton V. Johnson
Engineering Company, Inc.

precision miniature parts

95A SUMMIT AVENUE
SUMMIT 4, NEW JERSEY

For more information circle **81** on inquiry card.

NEW INSTRUMENTS



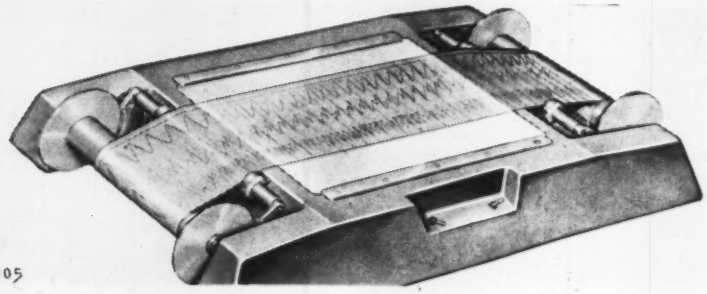
for subsequent data processing, shipping, rewinding and storage. A removable face reel can be used where preferable. New winder maintains constant tension on tape as it flows intermittently from punching equipment without damage to tape or motor of unit.—*Dresser Products, Inc., 152 Wheeler Avenue, Providence 5, R. I.*

For more information circle **307** on inquiry card.

COMPUTER VDR

New "Type 11 Ultra-Low Torque Potentiometer," 1.062" diameter, has a synchro type mounting, an essential for computer applications; is dimensionally interchangeable with other servo components. Single and three-gang units pictured are 0.81" and 1.81" respectively. Individual pot cups are 0.500" long and ganged assem-

OSCILLOGRAM VIEWER



New "Oscillograph Viewpak" viewer/editor enables on-the-spot quick-looks at oscillograms; has motorized paper drive, 16" x 18" backlighted viewing area, will handle rolls up to 7½" dia. Paper speed can be varied by means of a foot pedal between 0 and about 96 ips in either direction. —*Benson-Lehner Corp., 11930 W. Olympic Blvd., W. Los Angeles, Calif.*

For more information circle **308** on inquiry card.

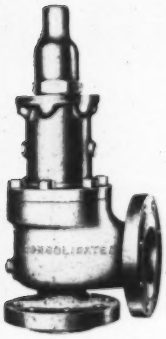
TRANSISTORIZED COMPUTER

New "Type S-1000 Transae" is designed for scientific application in research labs, industries, and universities. Its transistor circuitry eliminates bulky insulation and heavy power supplies required by vacuum-tube devices. Consuming about 1.2 kw, it generates so little heat that cooling normally needed for human comfort is sufficient. It can be plugged into 110-v 60-cps outlets. Principal characteristics: Parallel machine; 36-binary-digit word length, double-length 72-binary-digit accumulator; complementary binary arithmetic for internal calculations; two-address instructions with two 12-digit addresses, two 3-digit address modifiers and a 6-digit command; magnetic core memory with 20-usec cycle time; memory capacity 4,096 words; arithmetic speeds (exclusive of memory): add or subtr 5.5 usec, mult 130 usec avg, div 200 usec; cathode-ray memory-address reference indicator.—*Philco Corp., Government & Industrial Div., 4700 Wissahickon Ave., Philadelphia, Pa.*

For more information circle **309** on inquiry card.

WHAT YOU DON'T SEE

MEANS THE MOST



...in service

...in economy

...in protection

Few Functional Parts. Each part is precision machined and aligned to assure long valve life and minimum maintenance.

Economical "2 in 1" Design. Construction that permits you to convert the Standard valve to the Bellows type *in your own shop.*

Only One Adjusting Ring. Easy to set *before* the valve is installed to obtain peak performance at 4-5% blowdown. Whatever the ring position, *full relieving capacity is certain* because a fixed maximum secondary orifice provides full lift at 10% over-pressure. Even with "superimposed" back pressure in the relieving system, *valve action is consistently positive.*

Temperature-Compensating Disc. Temperature-induced stresses cannot distort the seat. Seating is always tight, even when nominal strains of unanchored discharge piping are present. Minimum guiding area is provided to align the seating surfaces – less chance of a sticking disc holder when corrosion or contamination build up on the guiding surfaces. The seating surfaces are optically-ground flat – servicing is easier, highly economical.

Huddling Chamber and Secondary Orifice Contours take full advantage of the stream pressure and kinetic forces – an exclusive safety feature.

Low-Placed Threaded Section Holds Nozzle in Valve. Assures high resistance to discharge of piping strains. No leakage from strain induced into the nozzle.

Standardized Inlet-Outlet Face-To-Face Dimensions permit easy interchangeability with the valves of some other manufacturers.

Certified and Approved. Both Standard and Bellows Valves – in the full range of sizes and pressures – are approved under ASME Unfired Pressure Vessel Codes and are certified by the National Board of Boiler and Pressure Vessel Inspectors.

Absolute protection for personnel and facilities . . . far fewer inventory and maintenance needs . . . long-term economy. Be assured on every count before you buy another safety relief valve. Investigate fully the quality of Consolidated Safety Relief Valves—then compare. *Write for Catalog 1900.*

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario.*

CONSOLIDATED SAFETY RELIEF VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** TULSA, OKLAHOMA

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Okla.* AIRCRAFT CONTROL PRODUCTS, *Danbury, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

For more information circle **82** on inquiry card.

The
Curtiss-Wright
"SNAPPER"

NEW CONCEPT... ADVANCED DESIGN
IN THERMAL TIME DELAY RELAYS

- Eliminates chatter with **snap action**
- Single-pole, double throw contacts
- Wide ambient range (−65°C +100°C)
- For military, commercial and industrial applications
- Metal envelope (7 or 9 pin) miniature or (8 pin) octal
- Glass envelope in 9 pin miniature
- Preset time delays in metal from 3 to 90 seconds, glass from 5 to 60 seconds

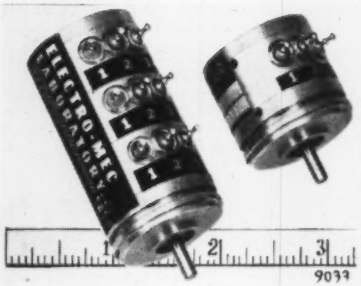
Write to Thermal Devices Department for latest data sheets

ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION • CARLSTADT, N. J.

For more information circle **83** on inquiry card.

NEW INSTRUMENTS

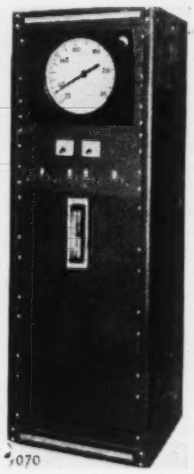
blies up to a dozen cups are available. Available with any resistance value up to 105,000 ohms; rated at 1 watt at 80°C; toroidal resistor element provides any electrical rotation angle, even to 360° when required. Standard linearity tolerance 0.5%, but 0.15% can be supplied in high resistance values. Non-linear functional output types also available.—*Electro-Mec Laboratory, Inc.*, 47-51 33*rd St., Long Island City* 1, *N. Y.*



For more information circle **310** on inquiry card.

PROCESS MEASUREMENT and CONTROL

PROCESS REFRACTOMETERS

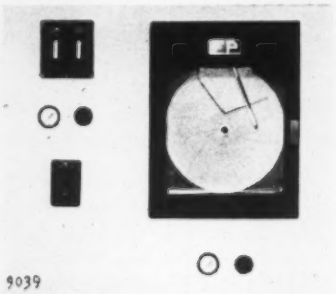


New "P-1000-C" (indicating, illustrated) and "PR-1000-C" (recording), for end point analysis and control, plot refractive index changes in any non-opaque liquid or gas stream. Applications include checking and controlling product purity; measuring and controlling blending of two streams; identifying compounds released from fractionators, stills, and chromatographic columns. Can be supplied to meet Class 1 Group D requirements for hazardous locations. Instrument is of null type; is designed for continuous operation on 115 vac; no batteries required.—*Phoenix Precision Instrument Co.*, 3803-05 *N. 5th St., Philadelphia* 40, *Pa.*

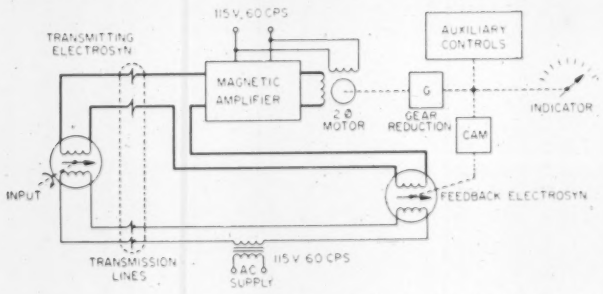
For more information circle **311** on inquiry card.

CONSISTENCY RECORDER

New "Plastometer, for continuous measurement of consistency of fibrous or pulpy slurries in food industry,



ELECTROMECHANICAL TYPE PROCESS INSTRUMENTATION



New "ElectroSyn" is a non-electronic signal generator system for measurement, indication, transmission and control of process variables. System can be enlarged. For example, local indication of pressure at a few points in a pipeline can be expanded to have information brought into a remotely located control station by adding an analog-digital converter, etc. True null balance (infinite gain at zero frequency) is said to assure maximal accuracy. Unlimited life is provided by electromagnetic transducers and magnetic amplifiers. Three basic components: signal transmitter, power unit (magnetic servo amplifier) and null-balance indicating receiver. Diagram shows arrangement for measuring pressure, differential pressure or flow. For measuring temperature, signal transmitter is simply a temperature-sensitive resistor ("bulb") and feedback "ElectroSyn" is replaced by a precision voltage-dividing resistor.—*Norwood Controls, Norwood, Mass.*

For more information circle **312** on inquiry card.

Contact points able to survive this brutal shear test stay on forever

STANDARDS THAT DETERMINE RELAY QUALITY

contact points that stay on for keeps

Superior attachment technique guards against insecure welds.

When you find a relay that sheds its contacts, you usually have a relay that's suffering from "cold welds"; this means that when the contact spring was made, the contact and the spring did not really weld together. When that happens, the contact is likely to fall off at any time.

We prevent that, here at Automatic Electric, by making contacts from a continuous length of precious-metal wire. In one combined operation, we weld the end of this wire to the spring blank (using very accurate control of time and voltage), pinch it off so as to provide exactly the right amount of material for the contact, and finally form it into a dome of the contact metal. Result: a contact with a polished surface, welded to the spring for the life of the relay. This is one more reason why Automatic Electric relays set performance records of 200 to 400 million operations without a failure!

This superior method is typical of the painstaking care that goes into *every* relay we make.

Class "A" Relay—for use when low first cost is important. *Write today for Circular 1702. Automatic Electric Sales Corporation, Chicago 7.* In Canada: *Automatic Electric Sales (Canada) Ltd., Toronto.* Offices in principal cities.

AUTOMATIC ELECTRIC

A MEMBER OF THE GENERAL TELEPHONE SYSTEM

ONE OF AMERICA'S GREAT COMMUNICATIONS SYSTEMS

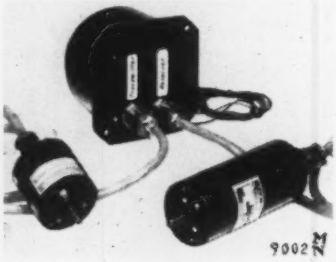
For more information circle **84** on inquiry card.

is unique in that it permits automatic consistency control of products as heavy as ketchup or applesauce. It comprises a simple hydraulic "flow-bridge," insensitive to flow-rate fluctuations. Consistency is recorded in arbitrary units which bear excellent correlation with those of either Adams or Bostwick consistometers. Range is said to be wider than those of consistometers currently available. Changes in range can be made without special tools or attachments.—*Fischer & Porter Co., 11 Jacksonville Road, Hatboro, Pa.*

For more information circle **313** on inquiry card.

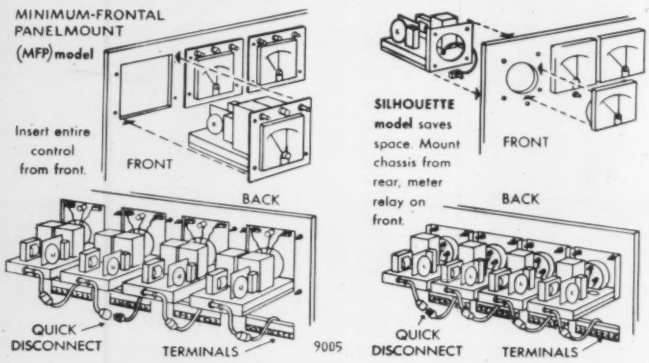
REMOTE POSITIONER

New "Model 11 Torsynator" is of self-balancing bridge type, said to feature "a new design concept in repeater units." Control network comprises two 360° precision wound voltage-dividing resistors. Each VDR has 4 taps 90° apart. Transmitter consists of one VDR; the other VDR is an integral part of receiver and its wiper arms are coupled to dc servomotor which "follows" at constant rate and constant torque. Maximum follow-up rate 60° per second.—*Air Marine Motors, Inc., Amityville, N. Y.*



For more information circle **316** on inquiry card.

SMALLER CONTROL-INSTRUMENT CHASSIS

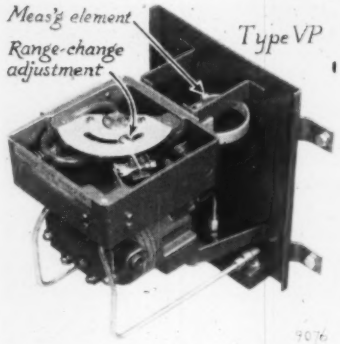


Two new chassis styles for maker's "Simplytrol" and "Versatrol" package controls were especially designed for original equipment; are furnished without side or top panels but most components are individually dust-covered. Both styles are available with all standard control circuits and components. Front panel of "MFP" can include on-off switches and indicating lights. Switches for "Silhouette" are mounted through panel.—*Assembly Products, Inc., Chesterland, Ohio.*

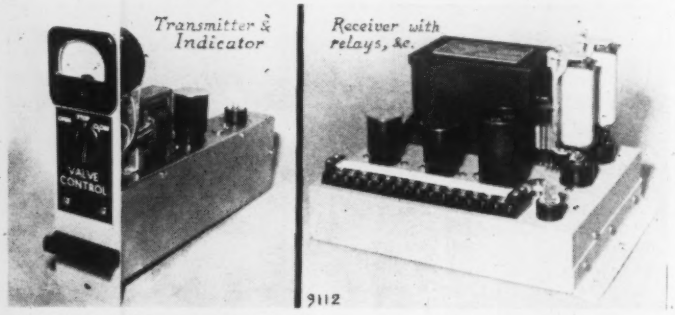
For more information circle **314** on inquiry card.

PNEUMATIC TRANSMITTERS

New force-balance dry-type "Model VP" (pressure) and "Model VDP" (differential pressure) transmitters utilize a unique "null-balance-vector" principle which reduces weight and permits stepless changing of an instrument's range by changing angle at which input forces are applied to nozzle-and-flapper linkage (thereby altering component of forces to be balanced). Change is simple, does not impair 0.5% accuracy, requires only that scale marking of remote indicator, recorder and/or integrator be changed to show new range. Standard models of both transmitters operate on 20 psi air and produce output signals from 3 to 15 psi, normally using about 0.2 scfm of air. Virtually all parts of both instruments are interchangeable, excepting primary measuring elements. These include dia-

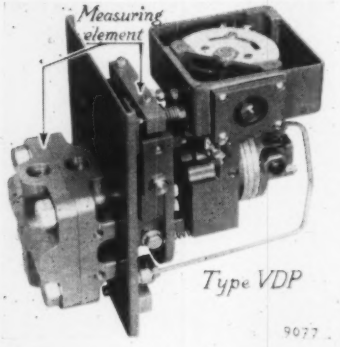


INDICATING REMOTE-POSITIONING SYSTEMS

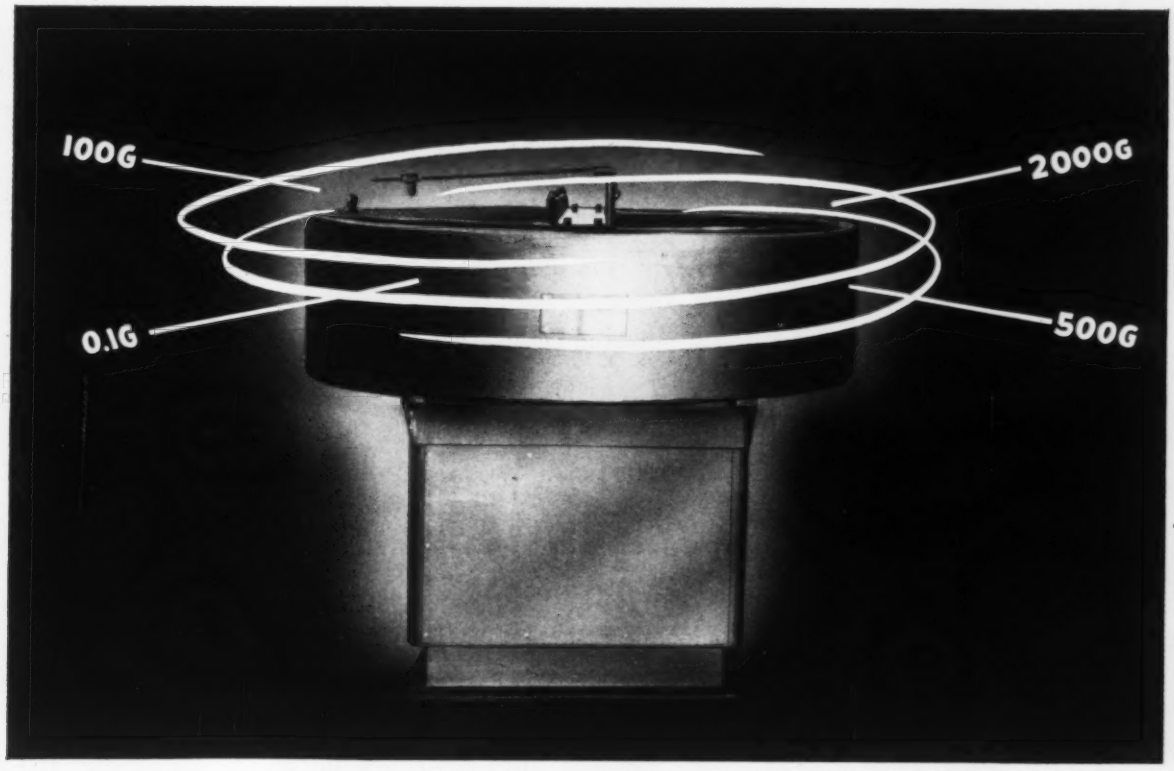


New "Synchro-Scan Position Indicator/Controller" units permit remote modulation and continuous indication of valves, gates, feeders and similar devices. Principal components: transmitter package, a plug-in unit, has a three-position (open, close, and off) switch mounted on its face to control remote device. Above this switch is a small voltmeter-type indicator graduated from 0% to 100% to indicate percent of opening or displacement. At receiving end, another packaged unit contains control relays and regulated dc voltage supply used to transmit position indication. A standard electric position transmitter is used to originate this voltage. Only two wires and a ground are required for transmission of the signal.—*Builders-Providence, Inc., 345 Harris Ave., Providence, R. I.*

For more information circle **315** on inquiry card.



ACCELERATION TESTING...



SCHAEVITZ Rotary Accelerators are available for calibration and environmental testing over wide ranges of acceleration. Objects from a tiny accelerometer to a large electro-mechanical assembly can be tested. These accelerators are characterized by: flexible speed control, accurate transmission of signal voltages, convenience and safety in use.

ONLY SCHAEVITZ HAS THE EXACT TYPE OF ROTARY ACCELERATOR TO MEET YOUR REQUIREMENTS

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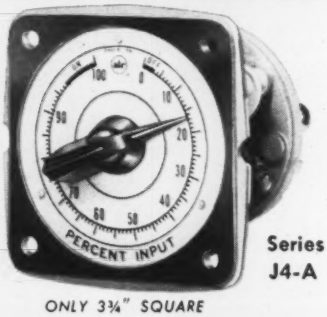
For more information circle **86** on inquiry card.

ELIMINATE POWER WASTE AND RHEOSTAT COSTS

NEW!
miniature
ATCOTROL
manual set
INPUT
CONTROLLER
provides stepless kwh control!



Series J4-A

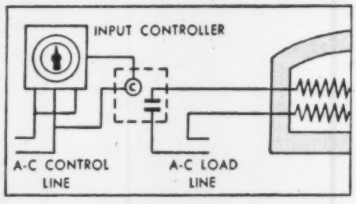
ONLY 3¾" SQUARE

When your electrically heated equipment needs less than full current, you set the Atcotrol Input Controller to the per cent of input you need and the controller automatically delivers the required heat without any waste. The standard unit operating on a one-minute time cycle can, for example, provide a 60% input by causing the current to be on for 36 seconds and off for 24. Resistance elements which overheat and need frequent replacement are thereby eliminated.

Also used on heaters, dehumidifiers, evaporators, driers, filters, presses, pumps, filling operations and other applications.

HEAVY-DUTY CONTACTS

Big, ⅜" diameter silver-load contacts are self-cleaning and quick breaking. Rated capacity is 25 amperes at 115 volts a-c, 20 amperes at 230 volts a-c, non-inductive load.



MOUNTING AND SERVICING FEATURES

Standard model (shown above) is mounted to panel by four screws. Deluxe model with plastic cover (similar to timers at lower left) requires no mounting screws. Synchronous motor needs no lubrication. Simple removal of sleeve housing provides quick access for inspection. Nylon cams and gears assure quiet operation. One piece mold fiberglass reinforced, back plate includes semi-circular terminal block. Each terminal protected by 270° arc barriers. Compact construction: 3¾" square by 4 11/16" behind panel.

Other members of the growing ATCOTROL miniature line

A-C TIMERS
Stop cycle, automatic reset.

D-C TIMERS
Stop cycle, automatic reset.

atc®
AUTOMATIC CONTROL SYSTEMS & COMPONENTS

AUTOMATIC TEMPERATURE CONTROL CO., INC.
Subsidiary of Safety Industries, Inc.
5224 Pulaski Avenue, Phila. 44, Pa.

Please send me complete data on Atcotrol Input Controllers.

NAME_____
COMPANY_____
STREET_____
CITY_____ZONE____STATE_____

FOREIGN SALES: ATC EXPORT DEPARTMENT, 1505 RACE ST., PHILA. 2, PA.

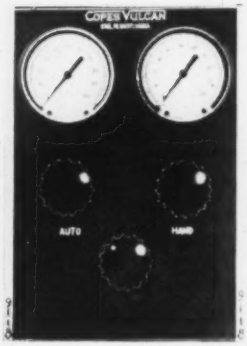
For more information circle **85** on inquiry card.

phragms, bellows or Bourdon tubes (illus) for measurements of gage pressures from 1.5" H_2O to 400 psi, and diaphragm assemblies for differential pressure measurements from 0-15 to 0-300" H_2O at static pressures up to 1500 psi. Since instruments balance forces, primary fluid flows are nearly zero; hence no contamination of measuring elements.—*Republic Flow Meters Co., 2240 Diversey Parkway, Chicago 47, Ill.*

For more information circle **317** on inquiry card.

CONTROL STATIONS

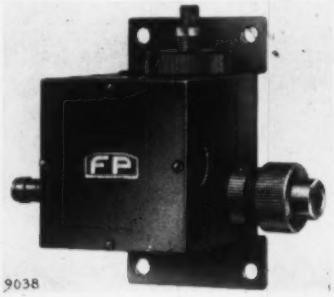
New standard and miniature models of pneumatic control stations are available for functions such as loading and transfer, selector biasing, ratio, remote set-auto manual, cascade auto manual, cascade-biasing, cascade-ratio, manual loading and bias-loading. New auto-manual pneumatic control loading stations (illustrated) are of non-seal type, assuring "bumpless" transfer without process disturbance or upset. Transfer is a simple matter of matching gage pointers and turning an adjustment knob. Design permits omitting one control station normally used in many cascade control circuits. Pressure range 3 to 15 psig, gages graduated 0-100%.—*Copes-Vulcan Div., Blaw-Knox Co., Erie, Pa.*



For more information circle **318** on inquiry card.

OXIDATION-REDUCTION PROCESS CONTROL

New "O-R-P Cell" responds to changes in relative concentration of specific chemical ingredients in liquid



MISSILE SYSTEMS ELECTRONICS

Activities at Lockheed Missile Systems Division laboratories in Palo Alto cover virtually every field of electronics related to missile systems. Inquiries are invited from those who desire to perform research and development of a most advanced nature.

Here staff members discuss a laboratory model of an airborne component of a guidance system. Left to right: Dr. R. J. Burke, telemetering; E. A. Blasi, antennas; K. T. Larkin, radar and command guidance; Dr. S. B. Batdorf, electronic division head; Dr. H. H. Leifer, solid state; S. Janken, product engineering.

Lockheed

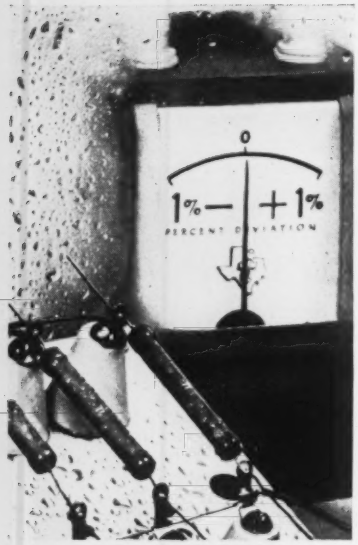
MISSILE SYSTEMS DIVISION

research and engineering staff

LOCKHEED AIRCRAFT CORPORATION

PALO ALTO • SUNNYVALE • VAN NUYS

CALIFORNIA



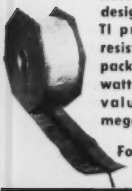
TI MIL-Line Precision Resistors

HOLD TOLERANCE . . .

EVEN WHEN DRIPPING WET!

Soaking wet, dried out, or 'shook-up' – TI MIL-Line deposited carbon resistors still far exceed MIL-R 10509B . . . emerge from one acceptance test after another – by major electronics manufacturers – with performance records that have not been equalled. *It's the seal that makes the difference* . . . an exclusive Texas Instruments process that snugly wraps these precision resistors in tough jackets of a special coating with high dialectric strength.

For ease in design, production, and maintenance . . . for improving the reliability and saleability of your products, the moisture resistance of TI deposited carbon MIL-Line resistors is just one field-proven factor. You also get a choice of 1, 2, or 5% tolerances . . . high stability over wide temperature ranges and under full load . . . low negative temperature coefficients . . . negligible voltage coefficient and noise levels . . . long shelf life . . . wide selection of sizes and resistance values . . . reasonable prices . . . and, if desired, reel-type packaging for automation.



Here is a typical TI reel pack designed to speed production. TI precision deposited carbon resistors are mass produced and packaged in five sizes from ½ watt to 2 watts with resistance values from 25 ohms to 30 megohms.

For complete data, write for Bulletin DL-C 539.

TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVENUE DALLAS 9, TEXAS

For more information circle **87** on inquiry card.

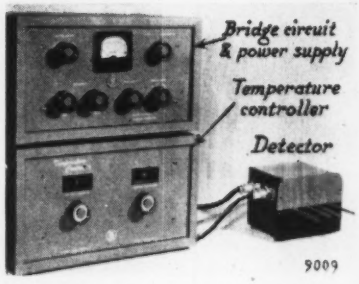
NEW INSTRUMENTS

vehicles; operates at pressures up to 35 psi and can be obtained alone or in combination with an F&P self-balancing potentiometer. Cell and potentiometer, in conjunction with electric, electronic or pneumatic controlling devices, can regulate either batch or continuous-flow processes. A feature of new cell is its straight-bore design which gives an unrestricted flow stream, eliminating deposits and plugging. Large electrodes minimize polarization effects. Contamination of reference electrode is prevented by a reservoir pressure 2 to 5 psi greater than that of static pressure in cell itself.—*Fischer & Porter Co., 2000 Jacksonville Rd., Hatboro, Pa.*

For more information circle **319** on inquiry card.

CONDUCTIVITY CELL FOR CHROMATOGRAPHIC ANALYSES

New "Model 75" high-temperature thermal-conductivity cell extends effective operating range of chromatographic analyses; operates over range



of 30°C to 325°C and accommodates liquids with boiling points up to 475°C (virtually at upper operating limit of chromatography); is said to achieve for the first time exceptional stability and sensitivity at these high temperatures by use of flake thermistors as sensing elements. Components: (1) detector proper enclosed in a specially-designed oven for minimal drift at maximal sensitivity; (2) temperature controller, 30°C to 350°C, with proportional mode of control; (3) bridge circuit and power supply.—*Barnes Engineering Co., Stamford, Conn.*

For more information circle **320** on inquiry card.

TEMPERATURE

SURFACE-TEMPERATURE PLATINUM-GRID ELEMENT

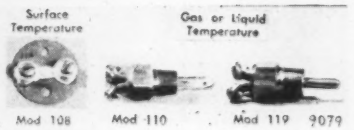
New platinum-grid element for accurately measuring temperatures between −320°F and 950°F (minimum

span 100 F°) was designed originally for use on guided missiles; can be attached easily to any surface with a special dielectric cement provided by maker. Grid interstices provide an excellent mechanical interlock and construction is said to guarantee sturdiness and "much greater accuracy than is common in resistance temperature measurement." To go with new primary element, maker has developed a 2- or 3-conductor tape composed of strands of fine silver woven into porous glass. It can be attached to surfaces with the same cement used for grid.—*Charles Engelhard, Inc., 850 Passiac Ave., East Newark, N. J.*

For more information circle **321** on inquiry card.

THERMISTOR PROBES

New "Models 108, 110 and 119" temperature probes, of thermistor type, are designed for airplanes, missiles, and other applications requiring small size and vibration resistance. Upper range limit is 500°F.



"Time constant" for "Model 108" is 7 sec when quickly applied to an aluminum plate; for "Models 110 and 119" 0.5 and 4.0 sec respectively, when immersed in slowly-agitated water. "Model 108" is particularly intended for measurement of surface temperature and the others for fluids, including highly corrosive fluids.—*Rosemount Engineering Co., Rosemount, Minn.*

For more information circle **322** on inquiry card.

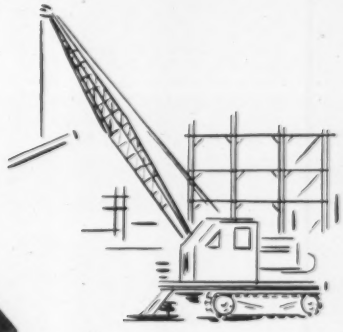
TEMPERATURE CONTROLLER

New "Series 2300 V.H.S. Compact Control" consists of "V.H.S." (very high sensitivity) "Meter-Relay" and load relay together with other con-

MISSILES to MACHINERY

Century MODEL 420 ELECTROGRAPH

covers the oscillograph recording field



TELEMETRY APPLICATIONS

- QUICK-LOOK monitoring in the telemetry ground station permits continuous observation of missile in-flight programing results.
- ON-THE-SPOT monitoring permits making in-flight function corrections in controlled missiles or piloted aircraft.
- A NATURAL for mobile telemetry vans . . . compact, rugged, low power consumption, record is PERMANENT, no fading or fogging when exposed to direct sunlight.

INDUSTRIAL APPLICATIONS

- STRESS-STRAIN RECORDING with "first-hand" read-out during test.
- PERMANENT record obtained at test site may be stored indefinitely for purpose of future data reduction.
- PORTABLE — extremely useful for field test applications where a "multiplicity" of data must be collected with the least amount of instrumentation.
- No amplifiers required for many applications.

USES a variety of tubular mirror galvanometers pioneered by Century

ENGINEERS . . .

Check your requirements against these FEATURES!

- Permanent continuous record produced within recorder.
- Developed record may be viewed an INSTANT after exposure.
- HIGH CONTRAST photographic qualities . . . black intelligence traces are recorded on light colored background.
- As many as 24 intelligence channels may be recorded on the 8-inch x 200-foot record roll.
- Record is REPRODUCIBLE without loss of contrast by Ozalid, Bruning, etc., processes . . . NO deterioration due to ultra-violet exposure.
- Eliminates need for costly darkroom facilities.

COSTS NO MORE THAN OLD-FASHIONED METHODS

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Century Electronics & Instruments, Inc.

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Tel.: 3-3524

For more information circle **88** on inquiry card.

Panalarm Annunciator pinpoints process "off-normals"

In the process industries and among users of automatic machinery, trouble is minimized when it's caught early. That's the purpose of the Panalarm Annunciator System — a continuous monitor of your process.

One typical adaptation of the modular Panalarm system is engineered to differentiate between the first "off-normal" and subsequent "off-normals" caused by the first. This feature allows instantaneous recognition of the prime source of trouble in a "chain reaction."

Another adaptation is designed specifically for motor start-up and shutdown. It has also been successfully adapted for supervisory control, pump control and programming.

Your Panalarm sales engineer will be happy to make a survey of your requirements to determine whether a Panalarm system can aid productivity and safety in your process. For electrical and mechanical data on standard systems, request Catalog 100B on your letterhead.

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For more information circle **89** on inquiry card.

trol components, all in one package. Control action can be either "limit" or "automatic." Limit "Compacts" trip a relay and lock, must be reset externally. Automatic "Compacts" include an automatic interrupter for periodic reset. Also available are "low Limit" and "high and low" double contact models for detecting any change in temperature. Temperature limits −400° to 3000°F, −240° to 1650° C. All standard thermocouples, 4 ohms/mv (other values optional). Bimetal and thermistor compensation. Load Switch: spdt 5 amp 125 vac, non-inductive. A variable resistance (supplied optional) in series with thermocouple will change temperature setting.—*Assembly Products, Inc., P. O. Box XX, Palm Springs, Calif.*

For more information circle **323** on inquiry card.

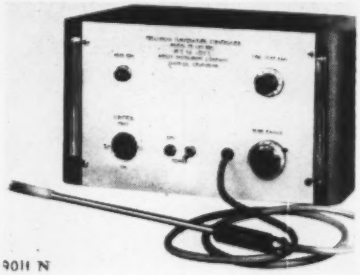
TOTAL TEMPERATURE PROBE

New "T-1305 and T-1004" total temperature probes, either boom or strut mounted, can be obtained with a choice of resistance thermistor or thermocouple sensing elements. Resistance elements can be precision wire wound with operating ranges up to 1000°F or of thermistor type. Thermocouple elements are available for operation to 2800°F. Employing double stagnation principle, probes have high recovery, negligible radiation and conduction errors, also rapid response to temperature changes. Probes of this type show complete insensitivity to 20° angle of attack and yaw. —*Aero Research Instrument Co., Inc., 315 N. Aberdeen St., Chicago 7, Ill.*

For more information circle **324** on inquiry card.

TEMPERATURE CONTROLLERS

New "Model 94" (−100°C to 100°C), "Model 95" (−30°C to 225°C) and "Model 96" (200°C to



9011 N

500°C) feature: (1) control accuracy of 0.001 C° which is verified by testing each instrument and its resistance-type probe before shipment; (2) absence of moving parts, achieved by electronic bridge and transistor amplifier; (3) convenient 115-v outlet on front panel for heater load. Controllers meet strictest requirements of viscosimetry, etc., in labs, as well as of critical processes in pilot plants.—*Bailey Instrument Co., Box 538, Danville, Calif.*

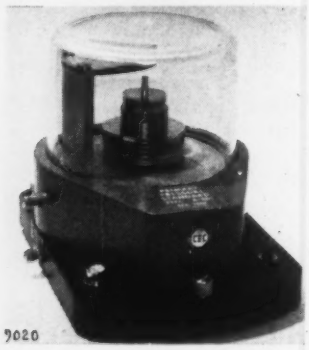
For more information circle **325** on inquiry card.

PRESSURE AND VACUUM

PRESSURE STANDARD

New "Type 6-201 Primary Pressure Standard" offers advantages of a frictionless pressure medium, extreme accuracy even at pressures of less than 1 psi, and portability regardless of pressure range. Principle: balancing controllable air pressure against force generated by a weighted piston. Friction between cylinder and piston is dispelled by momentarily actuating a motor-clutch assembly, which starts piston rotating. When Standard is used as a gage-type instrument, a dry air supply, a regulator, and device being calibrated are all that is necessary. Glass cover then merely protects against dust. When unit is used as an absolute instrument, glass chamber can be evacuated through reference-pressure fitting and weights are referenced to essentially absolute zero pressure.—*Consolidated Electrodynamics Corp., 300 North Sierra Madre Villa, Pasadena, Calif.*

For more information circle **326** on inquiry card.



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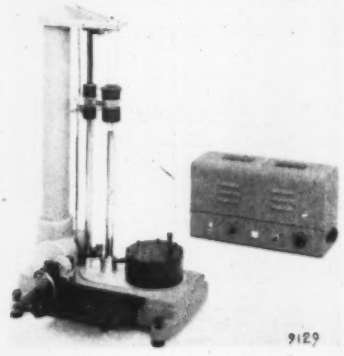
SERVOMANOMETERS

New servomanometers said to represent "the most accurate pressure measurement technique yet devel-



9129

FREQUENCY STANDARDS

AVIONIC
FREQUENCIES
PRECISION FORK

FREQUENCIES
240–400–500–1,000 cy.

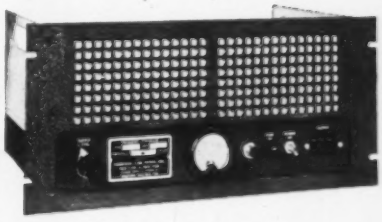
ACCURACIES
Type 50 ±.02% (—65° to 85°C)
Type R50 ±.002% (15° to 35°C)

TYPE 50

Requires double triode and 5 pigtail components

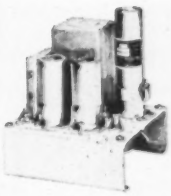
Size, 1" diameter x 3¾" high
Weight, 3.5 ounces

POWER
75 Watt
FREQUENCY STANDARD
TYPE 211IC



FREQUENCIES: .....50 to 1,000 cycles
ACCURACY: ..±.002% (+15° to +35°C)
OUTPUT: .....115V, 75 Watts
INPUT: .....110V, 50 to 75 cycles
SIZE: with cover....10"x17"x9" high
PANEL model,..10"x19"x8¾" high
WEIGHT: .....25 pounds

INDUSTRIAL



FREQUENCY STANDARD
TYPE 50L

FREQUENCIES
50–60–75 or 100 cy.

ACCURACIES
TYPE 50L
±.02% (—65° to 85°C)
TYPE R50L
±.002% (15° to 35°C)

INPUT: 150 to 300V, B (6 V at .6 amps.)
OUTPUT: .....2V into 200,000 ohms.
SIZE:..3¾"x4½"x5½" high. Wgt., 2 lbs.

This organization makes frequency standards within a range of 30 to 30,000 cycles. They are used extensively by aviation, industry, government, (armed forces) where maximum accuracy and durability are required.

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Company_____
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City_____

For more information circle 90 on inquiry card.

oped" are available in five standard ranges, 32" to 120", indicating in inches, centimeters, millibars or microns; gage, barometric, absolute or differential pressure; choice of servo characteristics. Principle: a differential transformer continously follows a float containing magnetic material. Units have been built with sensitivity of better than one micron. Balance position of differential transformer cannot be affected by aging components, line voltage variation, adjustment of electronic control, or change of vacuum tube characteristics. Glass or metal manometer tubes are available. Different liquids can be used in the same instrument—*Exactel Instrument Co., 5545 Eva Ave., Los Altos, Calif.*

For more information circle **327** on inquiry card.

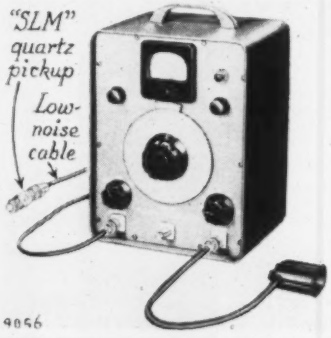
PRESSURE MEASURING CELLS

New "FMM" differential pressure cell with increased capacity and accuracy for measuring fluid pressure is of "SR-4" strain-gage type; replaces "FMB cell." Improvements include: New differential pressure capacities ±15, 30 and 60 psi; line pressure to 90 psi; increased output to 3 mv/v; 240-ohm bridge permitting higher input; calibration accuracy to 1/10% full scale.—*Electronics & Instrumentation Div., Baldwin-Lima-Hamilton, 42 Fourth St., Waltham, Mass.*

For more information circle **328** on inquiry card.

RATE OF PRESSURE CHANGE DIRECT INDICATOR

New "Model PI-114 Pressure Rate Indicator" permits precision rate or dynamic pressure measurements "under the most severe conditions." Pressure change rate is converted into rate of change of charge in Swiss-made quartz crystal pickup; and resultant current is measured by an electrostatic type amplifier whose output voltage is displayed on a standard oscilloscope or recorder. Among features: wide pressure range (vacuum to 3000 psi, and to 30,000 psi with adapter); fast response (15 microsecond rise-time); high sensitivity (about 4 micromicrocoulombs/psi); extraordinary resolution (0.1 psi at 3000 psi or more); and static calibration by conventional methods. —*Kistler Instrument Corp., 15 Webster St., N. Tonawanda, N. Y.*



For more information circle **329** on inquiry card.

PRESSURE SWITCH

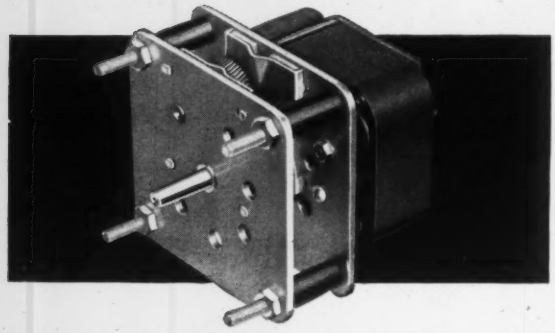
New "Model 501-A" differential pressure switch weighing 0.75 lb makes or breaks electric circuits when difference between two pressures is equal to or greater than preset value. Low and high operating pressures are 250 and 500 psig respectively. Adjustable differential is sensed by a diaphragm type capsule designed to withstand high overpressure without sacrificing sensitivity. Unit is designed to pass MIL-E-5272A Environmental Test.—*Gulton Industries, Inc., Metuchen, N. J.*

For more information circle **330** on inquiry card.

THE MARK OF QUALITY
BARBER COLMAN

Small Motors

now with new, improved gear reduction for radial thrust and overhanging loads

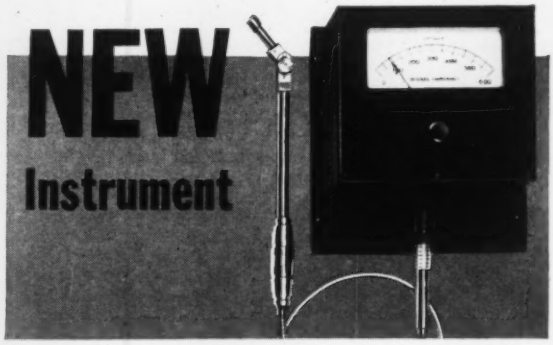


Here's a versatile new open-type geared Barcol motor in a *double-plate assembly* for extra ruggedness, quietness, and dependability. Heavy-duty gears and output shaft. Helical pinion and first gear provide quiet operation. Sintered bronze bearings lubricated by extra-large oil wicks. In gear ratios from 4:1 to 30,000:1. Starting torques up to 75 lb-in. Choice of synchronous or nonsynchronous unidirectional motors, or nonsynchronous reversible motors. High torque to inertia ratio of reversible motors is ideal for servo-mechanisms. Write for illustrated Catalog F-4271-7 on Barber-Colman Motors.

BARBER-COLMAN COMPANY
Dept. Q, 1215 Rock Street, Rockford, Illinois

For more information circle **91** on inquiry card.

NEW Instrument



Here's an important new addition to the field of surface temperature instrumentation. It's the new Alnor wall-mounted pyrometer with flexible arm.

The Type R-4200 Pyrometer combines the convenience of a portable and the instrument protection of a wall-mounted unit. It enables a manufacturer with a battery of ovens, platens, molds, etc., to locate a surface instrument permanently at each station for production checking of surface temperatures. Quickly and inexpensively attached to instrument board or any wall surface.

Available with flexible arm and choice of ten thermocouples in standard Fahrenheit ranges from 0-400° to 0-2000°. Centrigrade equivalents and special ranges, including below zero temperatures, also available.

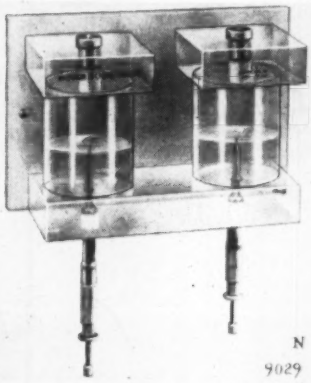
Write for Bulletin 2569. Illinois Testing Laboratories, Inc., Room 518, 420 No. LaSalle St., Chicago 10, Illinois.

Alnor **PRECISION INSTRUMENTS FOR EVERY INDUSTRY**

For more information circle **92** on inquiry card.

HOOK GAGE

New transparent hook gage greatly simplifies critical low-pressure and vacuum measurements; has full-scale



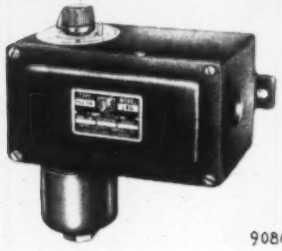
N 9029

range of 0-2" of water and features accuracy within 0.001". Suitable for all applications except fluctuating pressures, it is especially valuable in checking instruments. It comprises two water columns, each equipped with a stainless steel hook controlled by a depth micrometer.—*F. W. Dwyer Mfg. Company, P. O. Box 373, Dept. IUP, Michigan City, Indiana.*

For more information circle **331** on inquiry card.

PRESSURE AND VACUUM CONTROLLER

New "Type H27A Pressure-vacuum Control" provides two separate switch actions, permitting control of two



9086

independent circuits and flexibility of switch arrangement. It has a calibrated dial and single turn adjustment knob and pointer for making pressure settings. Individual switch adjustments are made by independent hex head screws located inside enclosure. Eight models in adjustable ranges between 0 and 180 psi limits. —*United Electric Controls Co., 79 School St., Watertown, Mass.*

For more information circle **332** on inquiry card.

DRAFT CONTROL SYSTEM

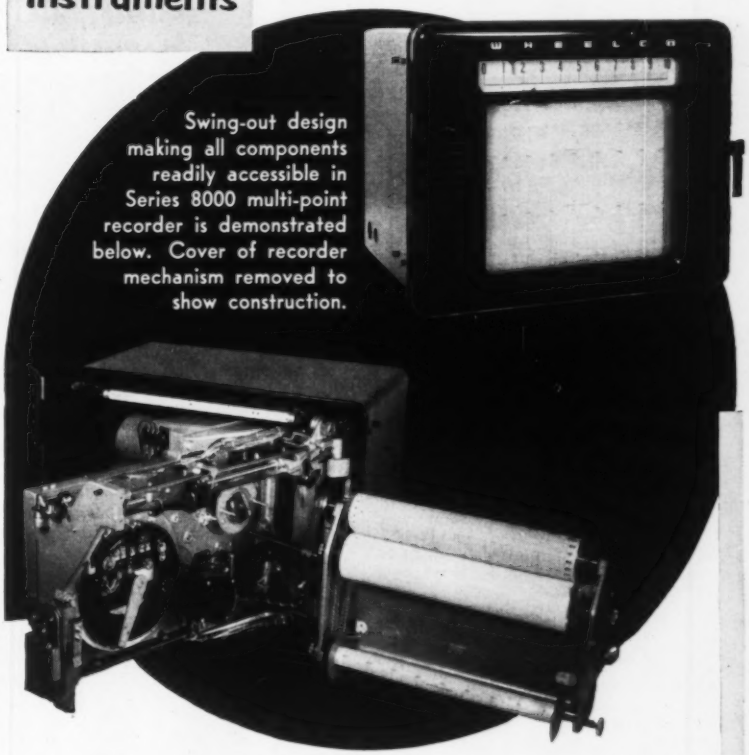
New "Adjustable Proportional Band Draft Controller" for commercial and small industrial power plants eliminates instability and "hunting"; operates at draft set point desired, after one simple field adjustment. Furnace fluctuations and

THE MARK OF QUALITY

BARBER COLMAN

Wheelco Instruments

New Series 8000 Multi-point Recorders Feature Easy Reading, Operation, and Service



Swing-out design making all components readily accessible in Series 8000 multi-point recorder is demonstrated below. Cover of recorder mechanism removed to show construction.

Permanent recording of as many as 16 points on one chart — at standard recording speeds ranging from 3 to 24 inches per hour — is readily obtained on Wheelco Series 8000 multi-point recorders. Thermocouples, radiation detectors, and other sensing devices that resolve the measured variable into an electrical signal all work equally well with the new recorders.

Additional features include: up to six limit switches for high and/or low signal indication, single or multi-color printing, and fast cross-chart speed. Call your nearby Wheelco field engineer today for Bulletin F-7955, or to discuss how these multi-point recorders can improve your processing.

BARBER-COLMAN COMPANY

Dept. Q, 1515 Rock Street, Rockford, Illinois, U.S.A.

BARBER-COLMAN of CANADA, Ltd., Dept. Q, Toronto and Montreal, Canada

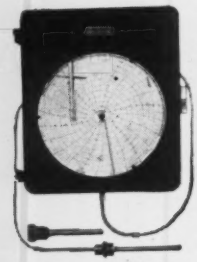
Industrial Instruments • Automatic Controls • Air Distribution Products • Aircraft Controls • Electrical Components • Small Motors • Overdoors and Operators Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

For more information circle **93** on inquiry card.

4½" DIAL THERMOMETERS

Made in 3 types to suit any requirements. Rigid stem, wall or flush mounted, 11 inches of scale reading. Interchangeable with standard industrial separable sockets. Stem can be placed at any angle and case can be rotated to any readable position.

PALMER
MERCURY ACTUATED
Temperature Indicating Instruments



RECORDING THERMOMETERS

Twelve inch die-cast aluminum case with black or white wrinkle or satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges —40 +950°F or Equivalent in °C.

INDUSTRIAL THERMOMETERS

Red-Reading Mercury —Extruded brass case — chrome finish. Ranges —40 + 950°F or Equivalent in °C.

RED-READING MERCURY LABORATORY THERMOMETERS

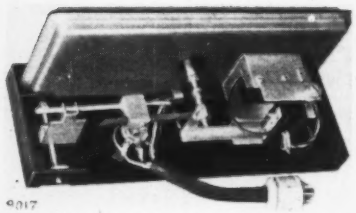
Thoroughly annealed for permanent accuracy. Complete line A.S.T.M. and fractional division types.

Write For Catalog Information

PALMER
THERMOMETERS, INC.
Cincinnati 12, Ohio • MElrose 1500

For more information circle **94** on inquiry card.

pulsations are filtered out without sacrificing resolution sensitivity. This allows actuator to establish a definite damper position corresponding to any given firing rate.—*Cleveland Fuel Equipment Co.*, 1111 *Brookpark Road, Cleveland 9, Ohio.*



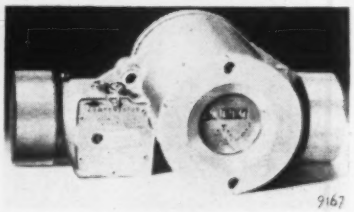
9017

For more information circle **333** on inquiry card.

FLOW-RATE and VOLUME

LIQUID FLOWMETER

New "Model A3T Type 20AA20E" 2" pipe size flowmeter, especially designed for bulk measurements of LP



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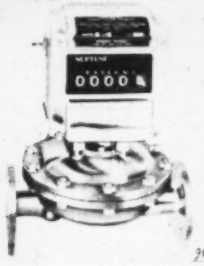
gas, has a capacity of 25 to 200 gpm and a working pressure of 600 psig. Registration is non-electrical and directly on a 6-digit totalizing non-resettable mechanical counter. Utilizing "Vortex-Velocity" principle of flow measurement, meter is accurate to 1% and does not depend on maintenance of clearances between mating parts, of which there are none. Overall length 12"; weight 7 lb. Simple to install and to service.—*Rotron Controls Corp., Woodstock, N. Y.*

For more information circle **334** on inquiry card.

S-S LIQUID METER

New Stainless Steel Meter makes it possible to obtain close metered control over corrosive solutions and chemicals which must be kept pure; will maintain its high accuracy over long periods of service in batch mixing and general process work; ends processing problems caused by metal pick-up or contamination of liquids being metered. Capacity of this 1-½"



3152

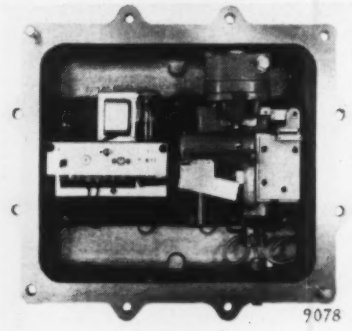
meter ranges from 20 gpm minimum to 100 gpm maximum for most liquids. Available with a choice of maker's direct-reading, ticket-printing or "Auto-Switch" registers. Latter can be used to operate valves, pumps, signals, agitators, etc., in automatic batching or processing operations. Registers can be calibrated for U. S. gallons, pounds, Imperial gallons, liters, and other units. Calibration adjustments are easy to make.—*Neptune Meter Co., 19 W. 50th St., New York 20, N. Y.*

For more information circle **335** on inquiry card.

LIQUID LEVEL

LEVEL CONTROL SYSTEM

New explosion-proof model of "Pneutronic" combination pneumatic-electronic level controller is intended for use in Class I, Group C and D



9078

and Class II, Group E, F and G hazardous locations. "Pneutronic" utilizes best advantages of electronics and pneumatics. Capacitance-actuated, it converts change in level into a proportional air output. Probes usually are rigid rod-shaped structure, supplied in standard sizes and models. —*Robertshaw-Fulton Controls Co., 2920 N. 4th St., Philadelphia 33, Pa.*

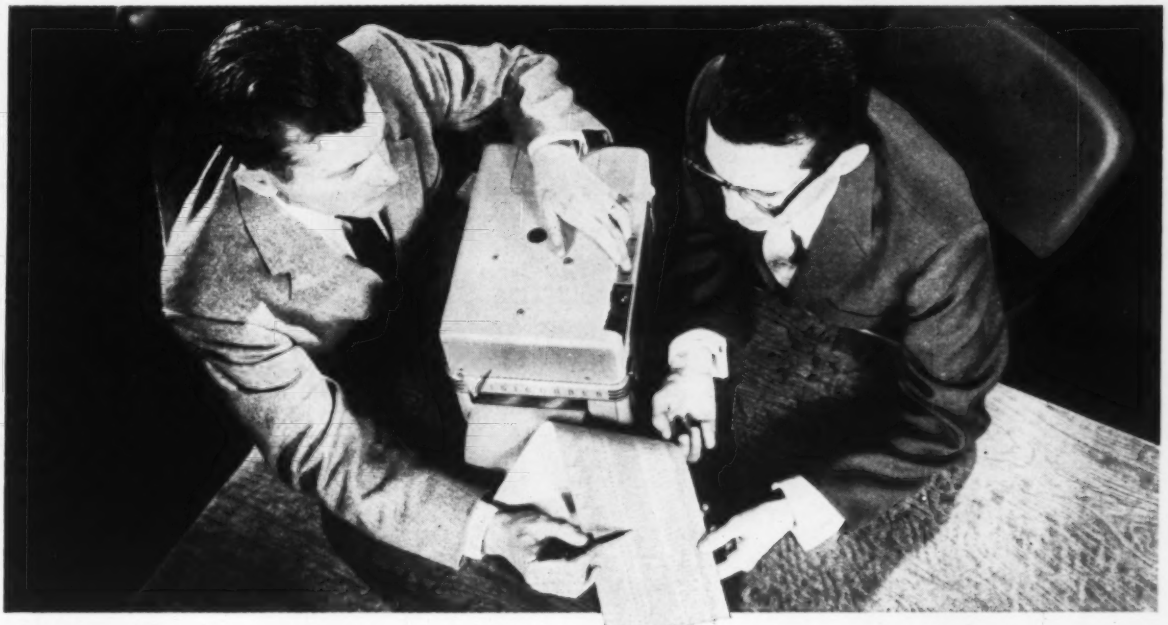
For more information circle **336** on inquiry card.

FULLY COMPENSATED BOILER DRUM LEVEL RECORDER

New "Compensating Level Recorder" provides automatic compensation of drum level measurements over entire boiler operating range. A Bourdon helix compensator, operating from

phone now!

for a prove-it-yourself demonstration of the Honeywell VISICORDER®



We're sure, once you've seen the fabulous new Visicorder demonstrated, that you'll be as enthusiastic as the thousands of others who have watched the Visicorder in operation.

That's why we're inviting *you* to be the judge . . . to call your nearest Honeywell Industrial Sales Engineer.* He will set up a Visicorder demonstration in your office, plant, or laboratory . . . at your convenience.

The Visicorder, in the short months since its introduction has become the most wanted oscillograph in America. Why? Because the Visicorder records at frequencies from DC to 2000 CPS, with sensitivities that compare to photographic oscillographs. Because the stable, direct-reading Visicorder records are reproducible, and permanent under ordinary usage. Because the Visicorder bridges the gap between mechanical direct-writing oscillographs and photographic-type instruments.

So accept this invitation: Call your nearest Honeywell Industrial Sales Engineer today. He will arrange for you to operate the Visicorder yourself so that you can see for yourself how the Visicorder fits your most complex recording application.

also ANNOUNCING . . .

The high-frequency Visicorder galvanometers have been redesigned to provide sensitivity improvements as great as 4 times, and a new 1000-cycle galvanometer has been added. All high-frequency galvanometers shipped after March 15 are to the new specifications.

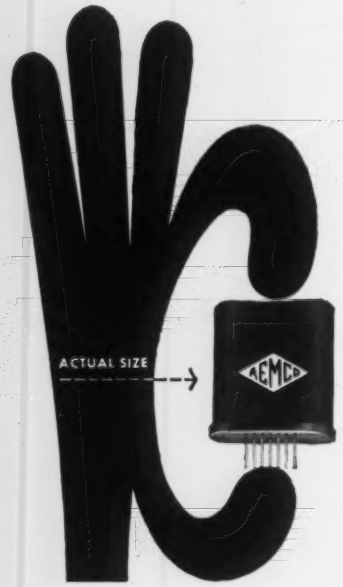
MINNEAPOLIS **Honeywell** H HONEYWELL

HEILAND DIVISION

5200 E. EVANS AVENUE • DENVER 22, COLORADO

*Visicorder demonstrators are now based in these Honeywell Industrial Sales Offices: Albuquerque • Atlanta • Baltimore • Boston • Buffalo • Cleveland • Dallas • Dayton Denver • Detroit • El Paso • Hammond, Ind. • Hartford • Long Island City • Los Angeles • Omaha • Pittsburgh • Philadelphia • Richmond • San Diego • San Francisco Seattle • St. Louis • Syracuse • Toronto, Ont. • Union, N. J. • Washington D. C. • Amsterdam, Netherlands • and more on the way.

For more information circle **95** on inquiry card.



need sub-miniature relays?

AEMCO'S Type 95 Sub-miniature Relay is "first choice" for design engineers working toward miniaturization and modification of existing equipment. Sealed in a tiny crystal case, AEMCO'S 95 relay weighs less than ½ ounce . . . measures only .78" in length! Now available with a wide variety of terminals and mountings, this relay is adaptable to a number of applications previously limited.

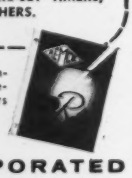
TWO BASIC UNITS AVAILABLE: 95-2029 with DPDT contacts rated at one amp. @ 28 VDC. 95-2267 with either one of two combinations, (SPDT and SPST-N.O. or, SPDT and SPST-N.C.) rated at 0.25 amps @ 28 VDC, permitting design variation to fit most applications.

OTHER RELAY TYPES AVAILABLE

Typical of AEMCO ingenuity, type 95 Sub-miniature Relay is just one unit from AEMCO'S complete relay line. Others are available in a wide choice of spring and coil combinations, operating potentials and contact ratings. If one of the hundreds of AEMCO relay types does not exactly meet your specifications, we will be happy to design and manufacture a unit to meet or exceed your requirements.

AEMCO also manufactures a complete line of SEQUENCE and AUTOMATIC RE-SET TIMERS, TIME SWITCHES, and SIGN FLASHERS.

WRITE TODAY—Your inquiries are invited. Ask for Bulletin "H" which describes the 95 as well as other relays in the complete AEMCO line.

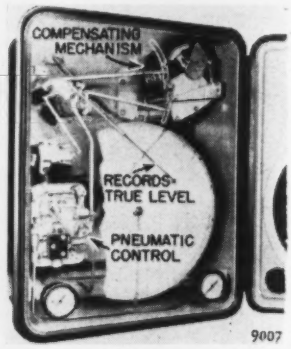


AEMCO INCORPORATED

83 State Street • Mankato, Minn.

For more information circle **96** on inquiry card.

NEW INSTRUMENTS

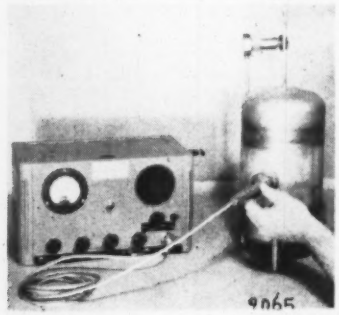


drum pressure, offsets effect of any change in specific weight of water so that, at saturation conditions, complete compensation is achieved over entire ranges of level, pressure, and temperature.—*Bailey Meter Co., 1050 Ivanhoe Road, Cleveland 10, Ohio.*

For more information circle **337** on inquiry card.

LEVEL INDICATOR FOR LIQUID METALS

New liquid metal level indicator, sensitive to 1 mm, performs measurements through vessel's wall, obviating



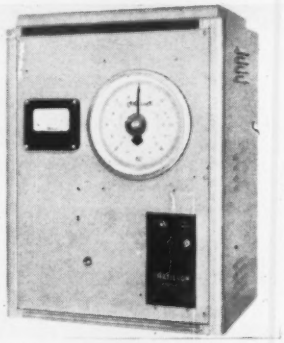
need of an internal probe; utilizes a balanced inductance bridge circuit. —*Nuclear Development Corp. of America, White Plains, N. Y.*

For more information circle **338** on inquiry card.

FORCE, ACCELERATION, VIBRATION, etc.

RUNNING TORQUE TESTERS AND DYNAMOMETERS

Two new models in "300 Series" and a new "400 Series": New "311-RT/DY" and "321-RT/DY" lack high



degree of accuracy offered in regular line; are less expensive; are "definitely the best available testers in this category." ★ New "400 Series" fills need for high torque readings. Thus, maker now can supply a series of running torque testers and dynamometers capable of testing subfractional electric motors from zero to 4 oz-in and up to 64 lb-ft.—*John Chatillon & Sons, 85 Cliff St., New York 38, N. Y.*

For more information circle **339** on inquiry card.

FREE GYRO

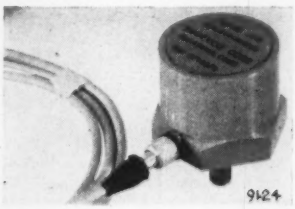
New "Series FG 01-0203-1," said to be "an extraordinary free gyro," has a solenoid-powered caging system featuring minimal number of parts and positive and reliable operation. Precision voltage-dividing resistor pick-off can be furnished with taps if desired. New gyro's smallness (5½" long) and light weight (3½ lb) are

said to make it "ideal for missile and aircraft instrumentation." Other features: cage indicating switches, and flexibility in choice of motor: 400-cps 115-V (three-phase or single phase), or 28 vdc.—*Humphrey Inc., 2805 Canon St., San Diego 6, Calif.*

For more information circle **340** on inquiry card.

LOW-G ACCELERATION PICKUP

New "Model 2218 Accelerometer" measures acceleration values down to 0.03 G. Minimum sensitivity of 40 mv/*G* is assured by Piezite I ceramic element. Natural frequency of 20 kc minimum gives response from 2 cps to over 4,000 cps with 5% linearity. Response to high-level audio noise fields is virtually eliminated by clamped



Dave Taylor discusses DATA SYSTEMS

Digital measuring techniques, having made possible automatic handling of test data from wind tunnel, engine test and similar applications, have also focused attention on other areas.

Before the advent of digital techniques, most testing was satisfied by analog recording with manual transcription of data for further data reduction. In the majority of cases, each variable was handled as an independent instrumentation channel. Demands for greater precision and accuracy made digital instrumentation desirable. Increase in the number of measured parameters further demanded time-sharing of expensive items of equipment to maintain overall costs within economic limits. The result has been that the problems have become systems problems rather than primarily instrumentation problems.

A simplified test problem may be considered to be the acquisition of data from a multiplicity of transducer elements, representing pressures and temperatures in a digital form, for direct evaluation and in a reproducible form for further data reduction or data processing. Even though techniques and equipment are available for accomplishing the requirements, additional problems arise, which must be delicately handled from the standpoint of overall accuracy. A typical example is the wide range of full-scale values of measured pressures.

Full-scale ranges of pressure measurements may vary from a few inches of mercury to several hundred inches. Transducers operating at 300 inches of mercury may not be used for precision measurements over the range 0-30 inches of mercury because even with an accuracy of 0.1% at the higher range, the error is .3" Hg which becomes a 1% error in the lower range. With the rapidly increasing cost of transducers for accuracies better than 1%, a decision is required as to the way that cost may be best balanced against overall accuracy. Several solutions are immediately suggested: (1) supply a transducer of the proper range for each pressure; (2) supply a single pressure measuring system with an accuracy approaching .01% of maximum range; or (3) supply several transducers covering portions of the range with automatic selection of the proper transducer. Each of the solutions may offer the same degree of compromise, yet each presents its own inherent problems. A transducer of high accuracy for each pressure can become costly for large numbers of pressures and for required calibration time. A single pressure measuring system of extreme accuracy carries with it attendant switching of pressure lines and likely serious pressure stabilization time, as well as automatic selection complexities. Each solution may be considered equally proper for individual cases. A satisfactory choice of method can only be made in consideration of the overall aspects of the particular problem.

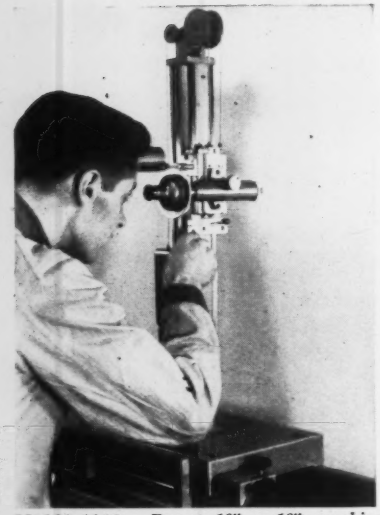
Dave Taylor discusses instrumentation in data handling systems.

It is evident that digitization has brought instrumentation problems into a tightly integrated unit. For improvement of present systems, early digitization of the analog signal is essential. When a truly digital transducer is developed, a completely digital system will be possible. Then new concepts will be applicable and the physical aspects of the measured parameters will become the major limiting factor of the system.

By applying the latest proven techniques, our well-qualified staff at Daystrom Systems is prepared to take single responsibility of assembling and installing a system to meet your needs. We are currently compiling a file of new applications and papers on various parts of systems, both industrial and military. If you are interested in receiving the file and periodic additions, please write us.

DAYSTROM SYSTEMS
Division of Daystrom, Inc., 5640 La Jolla Blvd., La Jolla, California, Tel. GLencourt 4-0421

For more information circle **97** on inquiry card.



M1238-1818 — *Range 18" x 18", working distance 9" to infinity. Reads to 0.001" up to 24" working distance. Protractor ocular reads to 3 minutes of arc. Image is erect.*

Cut inspection time in half

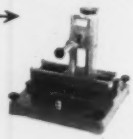
with new Gaertner Coordinate Cathetometers

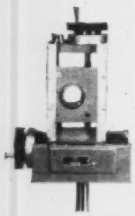
These convenient, reliable optical instruments permit making precise coordinate measurements in a vertical plane. The two dimensions are measured with one setting, object does not have to be rotated. Inspection time is cut in half and resetting errors eliminated.

Versatile Gaertner Coordinate Cathetometers are ideally suited for precision measurements on large objects; also objects or points in recessed, remote, or inaccessible locations. Applications include measuring jet engine sections, complicated castings, printed circuits, bolt holes and bosses on large piece parts, traces on cathode ray tubes, etc.

Because these are optical rather than mechanical measuring instruments, you make non-destructive measurements without contact, distortion, or concern about pressure being applied to the object when making a setting. Instruments available in English or Metric system.

M1236-46— Horizontal range 6", vertical range 4". Reads to 0.0001", working distance 5" to infinity.





M1236-22— Range 2" x 2", reads to 0.0001". Working distance 5" to infinity. Shown with 19 mm mounting rod, and without telemicroscope. Instrument permits precise coordinate movement of other objects such as photo cells, probes, etc., in place of telemicroscope.

Write for Bulletin 188-53

The Gaertner Scientific Corporation

1211 Wrightwood Ave., Chicago 14, Ill.
Telephone: BUckingham 1-5335

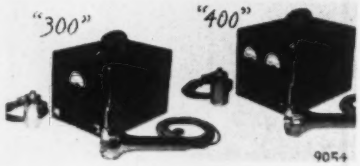
For more information circle **98** on inquiry card.

crystal design and internal acoustic shielding. Moisture-proof construction; weight 2 oz; size 1" hex; supplied with special noise-treated cable. —*Endevco Corp., 161 E. California St., Pasadena, Calif.*

For more information circle **341** on inquiry card.

VIBRATION ANALYZERS

New light-weight "Models 300 and 400" vibration analyzers measure, troubleshoot and "balance out" vi-

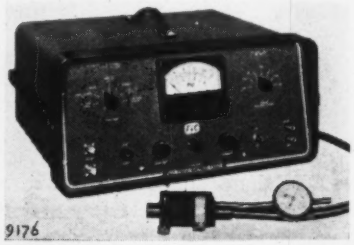


brations caused by rotating parts and assemblies. "Model 300" is intended primarily for in-place and production balancing; "Model 400" incorporates features for analyzing or trouble-shooting as well as balancing. Both can be used also as quality control devices to check permissible vibration tolerances. Sensitive pickups withstand abuse in industrial service. At maximum sensitivity, both models have a full-scale displacement range of 0.001".—*International Research & Development Corp., 797 Thomas Lane, Columbus, Ohio.*

For more information circle **342** on inquiry card.

VIBRATION CALIBRATOR

New "Model 501" utilizes a non-contacting probe, can measure vibrations of 10 to 20,000 cps with ampli-



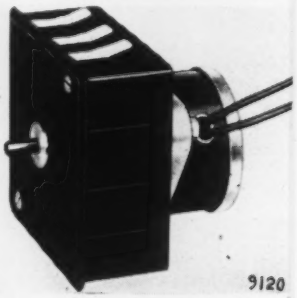
tudes of 20 to 20,000 microinches. It is designed to measure vibration amplitudes of non-magnetic metals such as copper, brass and aluminum while utilizing a minimum surface diameter of 7/8"; can be used also on magnetic metals as well as on non-metallic surfaces, by cementing a piece of copper or aluminum foil 0.01" thick and 1" dia to surface under transducer. Ranges 0.02, 0.06, 0.2, 0.6, 2, 6, and 20 mils, with ±5% accuracy attainable over all ranges. "Model 501" utilizes a unique method of comparing peak-to-peak displacement of vibrating surface with a standard displacement. No surface contact being required, there is no "loading" of the vibrating surface.—*Tel-Instrument Electronics Corp., 728 Garden St., Carlstadt, N. J.*

For more information circle **343** on inquiry card.

TIME, SEQUENCE, SPEED

INTERVAL TIMER

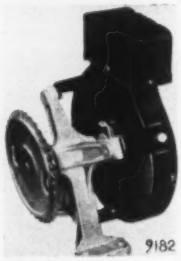
New 'Type 271" interval timer for built-in applications, is said to incorporate many effective design and



operational innovations; can be two-hole mounted or one-hole center mounted. Its molded Bakelite case houses one or two spdt or spst open-blade switches rated at 30 amp 115 vac resistive and 1/3 hp 115 vac. Permanent-magnet synchronous motor drives precision-cut cams which actuate switches at full scale intervals from 45 sec to 6 days. (Shorter than 45-sec ranges available with lower contact ratings).—*Cramer Controls Corp., Centerbrook, Conn.*

For more information circle **344** on inquiry card.

SPEED-RATIO RHEOSTATS

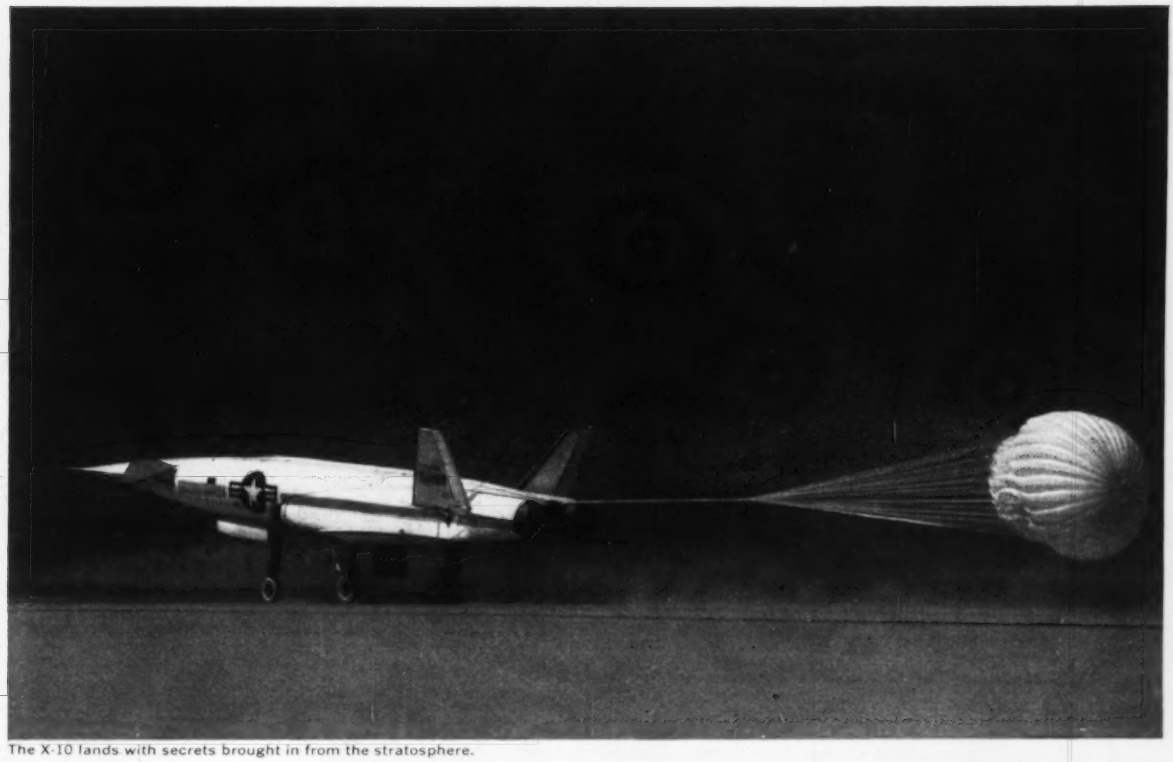


New "Bulletin 60" rheostats, for use on multi-motor drives where relative speeds between motors must be maintained within specific limits, afford a reliable but economical field control method essential to dancer roll service in textile, paper, steel mills and other process machinery. Among features: corrosion-resistant ball bearings; sprockets can be removed or added without disturbing assembly; large number of steps (up to 161 per plate); low operating torque; high watt ratings in small size; accommodates "Type S or M Vitrohm" rheostats.—*Ward Leonard Electric Co., Mt. Vernon, N. Y.*

For more information circle **345** on inquiry card.

SYNCHRONOUS MOTOR

New "Type 114" low-cost permanent-magnet synchronous motor (replacing "Type 113") features guaranteed torque of 30 oz-in at 1 rpm,



The X-10 lands with secrets brought in from the stratosphere.

X-10 missile test vehicle returns with good news for electrical engineers

New scientific data allows the Navaho Missile to leapfrog many R & D steps—go direct into advanced stages. Unprecedented success of the supersonic X-10 spells out this significant fact: The Navaho—an intercontinental strategic missile completely automated and constantly guided throughout its supersonic flight by self-contained control systems—is one of America's *most advanced* missile systems.

This news is important to you—whether you are a 10-year veteran or a recent BSEE. Why? Because now you can start at the very top of missile technology—and reap the rewards of being with a years-ahead company.

40 immediate career opportunities in electronic systems analysis

In Missile Engineering you'll investigate applications of automation that are literally strides ahead of the field. You'll pursue them in pre-flight, preparation, checkout, fueling, countdown and firing. You'll work on "in-flight" control and guidance systems so precise that even the environment within the missile must be rigidly controlled.

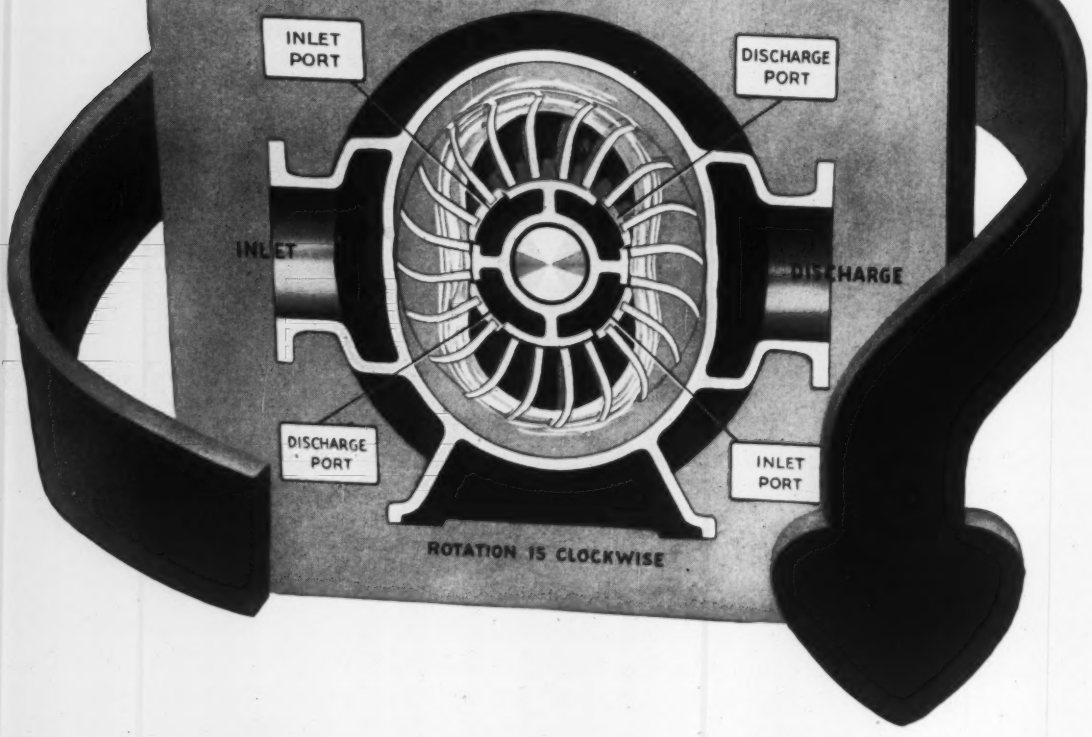
One of our immediate needs is for electrical engineers—especially those qualified in systems analysis, systems evaluation, component design and ground checkout. No matter what your experience has been it can be useful to us.

For complete details on these—and other engineering openings—please write: Mr. R. L. Cunningham, Engineering Personnel Manager, Dept 495-IA5, Missile Development Division, 12214 Lakewood Blvd., Downey, California.

MISSILE DEVELOPMENT DIVISION

NORTH AMERICAN AVIATION, INC.

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters



Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.
No dust filters.
No internal lubrication to contaminate air handled.
No internal wearing parts.
No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

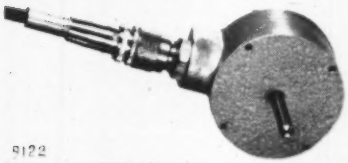
NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.

speeds from 60 rpm to ½ rpd, and rapid delivery on orders of all quantities. Designed for instruments, automatic controls, etc. Instant start and stop, low input (about 3.25 w) and permanent lubrication are among additional advantages.—*Cramer Controls Corp., Centerbrook, Conn.*

For more information circle **346** on inquiry card.

RPM PICKUP

New "Type 70 Rotary Transducer" provides 60 counts per revolution (higher available) from 10 to 12,000



rpm (to 20,000 rpm and above for non-continuous duty only). Size 2½" dia by 1"; weight 10 oz. Usable with various makes of counters, tachometers, etc.—*Dynapar Corp., 5150 Church St., Skokie, Illinois.*

For more information circle **347** on inquiry card.

LOAD-TIME RECORDER

New "Load Log" records loaded time of motor-driven machines or electrical apparatus which run constantly

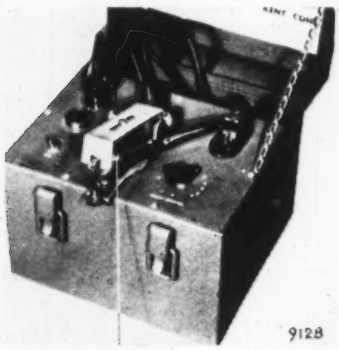
and are engaged by clutch to a load, such as IBM machines, machine tools and processing machinery; can be supplied in digits 999.9 to 99999.9 in hours or minutes and for 115v and up to 25 amp. (Adaptable to higher voltages by means of a resistor or transformer.)—*Capeway Instrument Corp., No. Bedford St., East Bridgewater, Mass.*

For more information circle **348** on inquiry card.

SHOP EQUIPMENT AND MATERIALS

THERMOCOUPLE WELDER

New miniature resistance welder is for use primarily in welding thermocouple junctions and leads, also as



a tacking welder to secure thermocouples, straingages, thermistors, etc., to large bodies. Built-in power supply can be connected to any 115-vac line; two types available: stored energy "Model PW 6" has a line drain of only 50 watts, yet delivers a welding pulse of 5,000 amp peak; "Model PW 6T" has electronic timer and heat regulation, is rated at 0.5 kva.—*Ewald Instruments, Kent, Conn.*

For more information circle **349** on inquiry card.

MINIATURE-GYRO BALANCER

New "Model K Dynamic Balancer," designed for precision balancing of miniature gyros, determines unbalance vibrations as small as one-quarter of one microinch, thus offers a solution to new problem of production balancing miniature gyros used in missiles.—*Micro Balancing, Inc., Garden City Park, N. Y.*

For more information circle **350** on inquiry card.

ULTRASONIC MACHINE

New portable bench-type "Sheffield-Cavitron" ultrasonic machine tool, for surface grinding and plunge cutting hard and brittle materials,

Stromberg-Carlson's new type "E" relay combines the time-proven characteristics of the type "A" relay with a mounting arrangement common to many other makes.

As the sketch above shows, our new frame mounting holes and coil terminal spacing allow you to specify these relays—*of "telephone quality"*—interchangeably with brands you have been using. Costs are competitive and expanded production means *prompt delivery.*

Welcome engineering features of the new "E" relay are—

★ **Contact spring assembly:** maximum of 20 Form A, 18 B, 10 C per relay.

★ **Coil:** single or double wound, with taper tab or solder type terminals at back of relay.

★ **Operating voltage:** 200 volts DC maximum.

You may order individual can covers in a choice of 3 sizes for the new relay, as well as for our type "A" and "C" relays.

For complete details and specifications on the "E" relay and other Stromberg-Carlson relays, send for your free copy of Catalog T-5000R.

STROMBERG-CARLSON

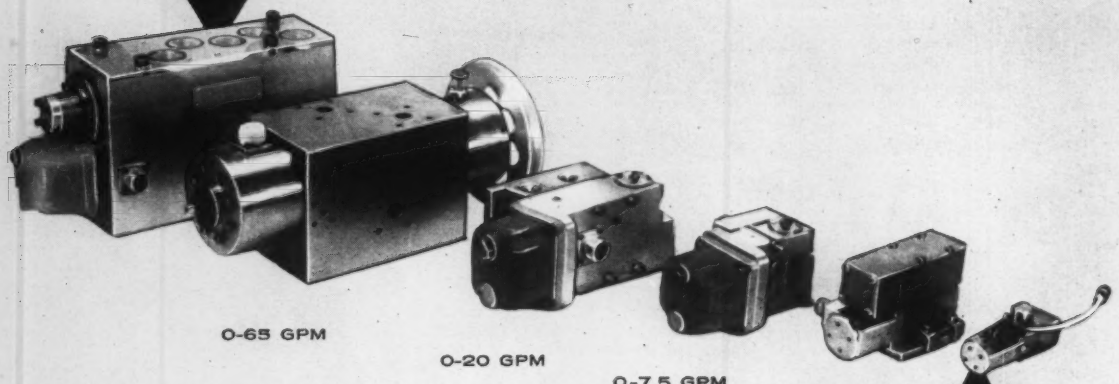
A DIVISION OF GENERAL DYNAMICS CORPORATION
TELECOMMUNICATION INDUSTRIAL SALES
113 CARLSON ROAD, ROCHESTER 3, N. Y.

For more information circle **99** on inquiry card.

0-175 GPM

SANDERS Electro-hydraulic

SERVO VALVES



...One of them may solve your problem

Among the most important operational advantages built into Sanders servo valves is adaptability. The standard models shown here are being used successfully in industrial, marine, and aeronautical applications of an ever-increasing variety. Their flow capacities range from 5 to 175 GPM at 1000 psi. across the valve, and 3000 psi. supply pressure. Valves with higher flow capacity can be produced to specification.

In fact, where conditions demand, Sanders offers a complete engineering service for designing special valves and hydraulic systems.

In addition to servo-valve diversification, Sanders' proven production ability is backed by extensive manufacturing facilities, precision equipment and skilled personnel.

Sanders electro-hydraulic servo valves feature . . .

- **Low resolution**
- **Compactness**
- **Wide frequency response**
- **Self-cleaning action**
- **Low input power**
- **Excellent linearity**
- **External adjustments**
- **Extended temperature range**

Want the detailed story? Write today for complete information. If you prefer, ask to have a Sanders Application Engineer call for consultation. No obligation, of course.

0-5 GPM

Industry's smallest valve.
Dim.: 1.1" x 1.1" x 3.9"

SANDERS ASSOCIATES INCORPORATED Dept. IA-5 NASHUA, NEW HAMPSHIRE

West Coast Field Office: 7335 VAN NUYS BLVD., VAN NUYS, CALIFORNIA, Tel. STATE 0-2720

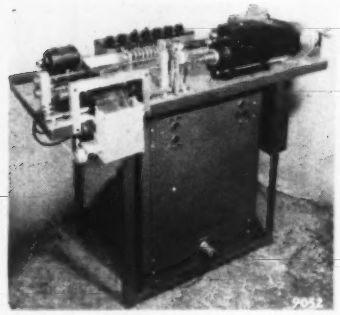
For more information circle **100** on inquiry card.

is about 27" high, features a slide-mounted transducer that converts high-frequency sound energy to mechanical energy; is powered by a 200-watt electronic generator; can cut a ½" diameter in one cut and can be adjusted vertically through a 3" feed range. A portable ultrasonic hand tool can also be used with the electronic generator.—*The Sheffield Corporation, Dayton 1, Ohio.*

For more information circle **351** on inquiry card.

SPIRALING LATHE

New "Model SL Spiraling Lathe," for production of deposited carbon and metal film resistors, is hopper



fed; cuts a helix on resistor, increasing its electrical value. When preset resistance is reached, cutting stops. Illustrated machine cuts helix on inside of a tube. Models are also available for external spiraling.—*Industrial Instruments, Inc., 89 Commerce Rd., Cedar Grove, N. J.*

For more information circle **352** on inquiry card.

POWER TOOL FOR CONNECTORS

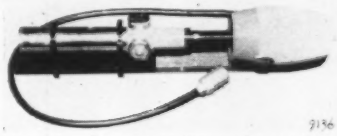
New "Electric Connector Driver" is specifically designed to apply maker's wire connectors quickly and

firmly: it joins wires to connectors with optimal twist and tension; its squeeze grip control pleases women operators. Splined driver sockets connect to motor shaft and fit particular wire connector used. New tool thereby minimizes assembly costs.—*Ideal Industries, Inc., 1420 Park Ave., Sycamore, Ill.*

For more information circle **353** on inquiry card.

TELESCOPIC ALIGNMENT KIT

New Tele-scopic Alignment Kit, for use by airframe manufacturers with maker's standard "Model PD-150"

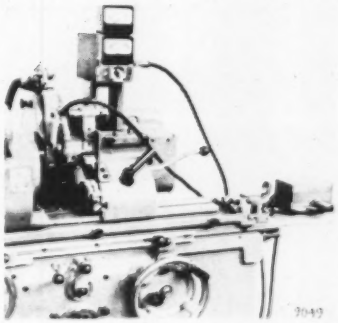


closed-circuit TV system (also shown), increases efficiency and accuracy in tooling problems calling for precision optical alignment by substituting precise visual communication for less certain oral or hand direction. Additional cameras and alignment kits are used when application requires more than one set of cross-hairs: with maker's camera switcher, aligner can make instantaneous reference to camera.—*General Precision Lab., Inc., Pleasantville, N. Y.*

For more information circle **354** on inquiry card.

GRINDER CONTROLLER

New "LI-AP Autopairer," said to be "based on a new electronic principle which permits automatic com-

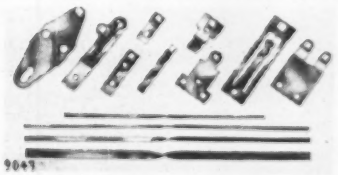


putation without sacrificing gaging accuracy," automatically controls any grinder to produce external pieces to fit bores within limits of desired radial play. Accuracy can be guaranteed to 0.000040", regardless of type of grinding machine.—*EAM Div., Industrial Gauges, Corp., West Englewood, N. J.*

For more information circle **355** on inquiry card.

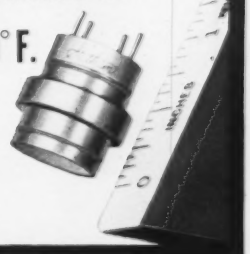
CONTACT ASSEMBLIES

New electrical contacts, formed from electrical contact tape, save manpower, facilitating assembly of



component parts into one integral unit. Tape introduces automation to manufacture of contact assemblies by machine-feeding contacts through

Miniature Pressure Transducers for operation to + 400° F.



Temperature compensated over 465°F. interval

0.01%/°F. thermal coefficient of sensitivity from −65° to +400°F.

0.01%fs/°F. thermal zero shift from −65° to +400°F.

No cement or resin pressure seals

Homogeneous sensing diaphragm surface

Statham unbonded strain gage transduction

Minimum response to vibration or acceleration

Pressure adapters for closed line applications

Absolute Pressure Transducers
0-5 to 0-500 psia – Model PA260TC

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0-5 to 0-500 psig – Model PG260TC

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When the transducer is a Statham, pressure measurements at elevated temperature are made with accuracy and confidence.

Complete specifications available upon request.

Please wire or telephone us collect whenever we may be of service.

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LABORATORIES
12401 W. Olympic Blvd., Los Angeles 64, Calif.

For more information circle **101** on inquiry card.

For Long—Trouble-Free Service

★ **VITREOUS ENAMEL TUBULAR RESISTORS**
In ratings from 3 to 200 watts.

★ **AXIAL LEAD RESISTORS**
In ratings of 4 and 7 watts.

★ **ADJUSTABLE VITREOUS ENAMEL RESISTORS**
In ratings up to 200 watts.

★ **CEMENT COATED RESISTORS**
In ratings from 5 to 200 watts.

★ **VITREOUS ENAMEL AND RW TYPES**
To meet Military Specifications.

For wire-wound resistors to meet exact circuit requirements—with the performance and ratings you need—look to Mallory. Mallory power resistors incorporate many design features to assure superior life, high physical strength, and ability to withstand thermal shock.

Mallory power resistors are available in a wide range of physical sizes, power ratings, coatings—to fit a wide variety of applications. A consultation with a Mallory resistor specialist can help you select the type best suited to your specific circuit design.

Complete information and data may be had by requesting Catalog 79-8.

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Metallurgical — Contacts • Special Metals • Welding Materials

Parts distributors in all major cities stock Mallory standard components for your convenience.

For more information circle **102** on inquiry card.

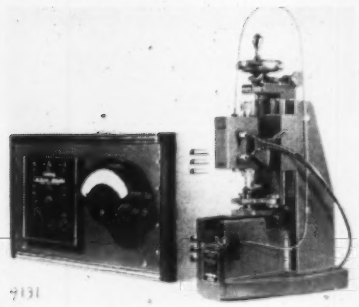
welding process. Tape is pre-formed to finished shapes with close tolerance limits and this shape is maintained during assembly process, whence precision sub-assemblies. Moreover, contact material facings need not be thicker than required for expected life, thus saving precious metal. Finally, clad electrical contact tape assemblies require less contact volume for required electrical and thermal values, and about 70% of face area of rivets for equivalent electrical capacity.—*General Plate Div., Metals & Controls Corp., Attleboro, Mass.*

For more information circle **356** on inquiry card.

DIMENSIONAL GAGING, INSPECTION

ELECTRONIC COMPARATOR

New "Model 130-B-9 Millionth Comparator," though originally built to measure precision ball bearings, is



completely adjustable and can be used for parts of various shapes and sizes. Any of four magnifications can be selected quickly by switching: from 60,000 to 1 (0.000001" graduations) to 2,000 to 1 (0.000030" graduations). Feature: Gaging spindle mounted within gage head on pantograph reed springs rather than in bushings; whence frictionless motion transfer and utmost sensitivity to minutest variation in workpiece size and exceptional repetitive accuracy.—*Federal Products Corp.*, 1144 *St., Providence* 1, *R. I.*

For more information circle **357** on inquiry card.

ADJUSTABLE HOLE GAGE

New "Kwik-Chek" hole gage is so simple to use that a child can gage hole diameters in 5 seconds or less.

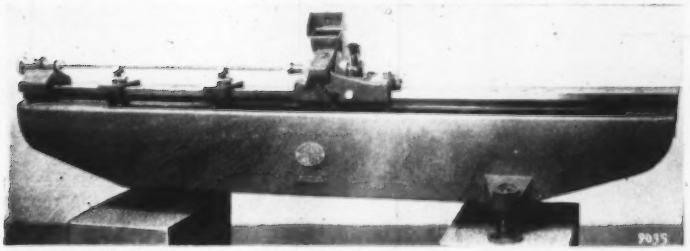
Accuracy and readability 0.0005"; complete set of three gages covers hole diameters from 0.025" to 0.380", each unit having a range of 0.125".—*Hamilton Watch Co., Allied Products Div., Lancaster, Pa.*

For more information circle **358** on inquiry card.

PLATING OR FILM THICKNESS GAGE

New "Type 255-A" measures plating and film thickness on conductive materials, such as anodic films on

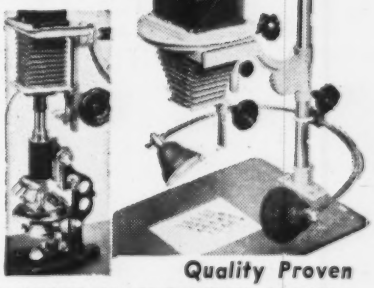
MEASURING MACHINES



New "Watts Length Measuring Machines," for precise measurement of lengths and diameters beyond sizes of longest practical gage blocks, provide a permanent universal standard to which gages and components can be set. "Type A" (illustrated) available for 80" to 120", has a measuring head which contains a 4" high-precision glass scale with projector reading directly to 0.00005" and repeating to a setting accuracy of 0.00001". A high-power microscope sets measuring head to master scale's 4" graduations. "Type B" (not illustrated) for measuring to 0.00001" at 30 feet, employs a sectional bed and a precision divided steel master tape under constant tension. Otherwise it is similar to "Type A." Work supports, coarse external scale and support plates, complete standard equipment.—*Engis Equipment Co.*, 431 *S. Dearborn St., Chicago* 5, *Ill.*

For more information circle **359** on inquiry card.

SOLAR LAB CAMERA



Quality Proven
MICRO-MACRO COPY CAMERA

INDISPENSABLE for research . . . for making permanent records . . . photographing small industrial parts, set-ups and processes . . . and in metallurgical or microscopic research . . . as used by Gov't. agencies and top research labs. Solar Lab camera features: extra long bellows extension, precision geared focusing system, interchangeable lens board, calibrated ground glass focusing, rigid upright mounting—permits raising, lowering or 360° tilting (also fits standard tripod). Accommodates all standard film and plate holders.

Complete 4x5" outfit: LAB Camera as described with 5¼ inch, F/4.5 imported anastigmat coated lens in self-cocking shutter 1 to 1/150th sec. T & B; 6, 4x5" cut Film Holders..... $145.00

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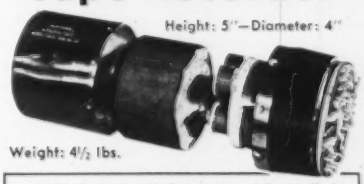
NORTHAM
Miniature Magnetic
Tape Recorder



Weight: 4½ lbs.

Eight channels of information can be applied simultaneously to a ½-inch tape in the Model MR-1 Recorder (illustrated). This self-contained unit includes transistor timing oscillator and battery power source and operates under axial accelerations up to 500 g. A pre-record carrier system permits direct coupling with D.C. devices such as thermocouples and strain gauge transducers.

MODEL MR-1 SPECIFICATIONS:
Accuracy:.....±5% full scale
Sensitivity:....28 millivolts D.C. full scale across 40 ohms impedance
Frequency Bandwidth:.....0-250 cps
Timing:.....1000 cps transistor oscillator
Running Time:.....45 seconds
Applications:....Running time, number of channels and recording characteristics are adaptable to meet requirements of applications—including rocket and aircraft flight testing, oil well logging and atmospheric studies.

WRITE FOR BULLETIN NO. IA-104

NORTHAM PRODUCTS INCLUDE . . .
Transducers for pressure, acceleration and displacement measurement and auxiliary electronic equipment for complete systems.

NORTH AMERICAN INSTRUMENTS, INC.
2420 North Lake Avenue • Altadena, Calif.

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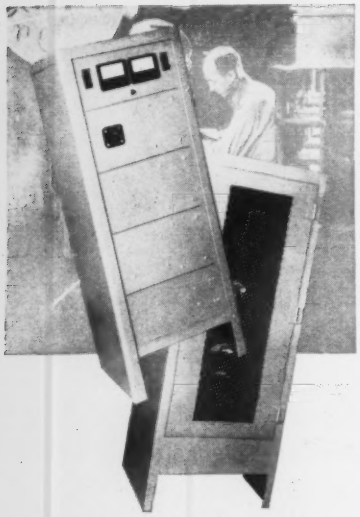

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inside or out, this cabinet
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Just like all our custom sheet metal work, this handsome cabinet is made right—will stand the most rigid inspection! It displays the kind of careful workmanship that has earned us our envied reputation for fine sheet metal fabrications. We are equipped to make almost any sheet metal part; we can stamp, shear, break, roll, weld, machine, assemble and finish all types of metal—aluminum, brass, copper, monel, stainless and all other steels. We have the facilities and the personnel to produce consistently top quality work, at competitive prices.

if you use sheet metal component parts, write
the
CINCINNATI VENTILATING
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310 Madison Ave.
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For more information circle **105** on inquiry card.

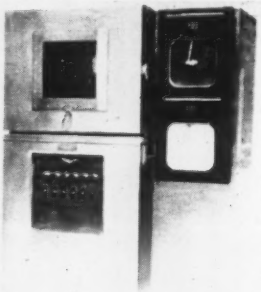
anodized aluminum, magnesium, and other non-magnetic basis metals, or insulating films such as organic paints, porcelain, enamel, and other non-conductive coatings. It also aids in sorting metals in accordance with their electrical conductivity and in matching metals in accordance with their magnetic properties. It also measures film thickness of non-magnetic platings such as silver, gold, cadmium, chromium, rhodium, etc., on such non-magnetic basis metals as copper, brass, aluminum, etc.; also thickness of conductive non-magnetic materials such as copper on insulating basis materials such as glass, phenolic sheet material, ceramic, etc. —*Boonton Radio Corp., Boonton, N. J.*

For more information circle **360** on inquiry card.

MECHANICAL TESTING

ENVIRONMENT TEST CHAMBER

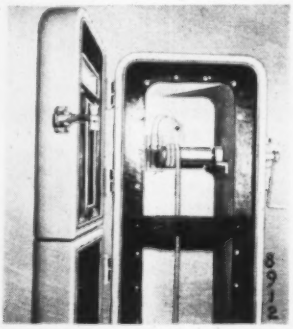
New "H8 Humidity Test Chamber" surpasses MIL specs; simulates environmental conditions throughout ranges of 0°F to 200°F and 5% to 98% relative humidity. Controls include 12"-chart wet & dry bulb recorder-controller, time-cycle programmer. Better than 2 F° control tolerance is maintained. Test volume 8 cu ft; interior dimensions 30" w x 20" d x 24" h. Low air velocities throughout test space.—*Environmental Equipment Co., 369 Linden St., Brooklyn 27, N. Y.*



For more information circle **361** on inquiry card.

WIRE-TESTING CHILLER

New "Model U-70-6" chilling machine, engineered especially for testing stability of electric wire insulation, subjects insulation to stresses at sub-zero temperatures. Manually-rotated shaft supports weighted lengths of wire. Temperature is adjustable from −10°F to −80°F; thermal capacity 200 Btu/hr at −70°F under normal ambient conditions. Dimensions: 84" h, 20" w, 42"d; insulation 4" of "Santocel A."—*Cincinnati Sub-Zero Products, Reading Rd., at Paddock, Cincinnati 29, Ohio.*

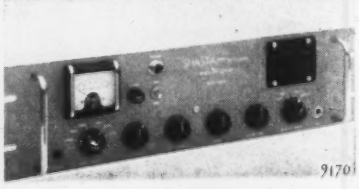


For more information circle **362** on inquiry card.

ELECTRICAL TESTING

WWV RECEIVER

New "Model 905," for conveniently and accurately utilizing standard time and frequency broadcasts of NBC stations WWV and WWVH, features: (1) all six frequencies selectable by front panel switch; (2) all three audio filters selectable by front panel switch; (3) 1-microvolt sensitivity on all bands; (4) individual crystals for maximum convenience, accuracy and stability; (5) logarithmic signal strength meter for precise tuning.—*Shasta Div., Beckman Instruments, Inc., P. O. Box 296 Station A Richmond, Calif.*

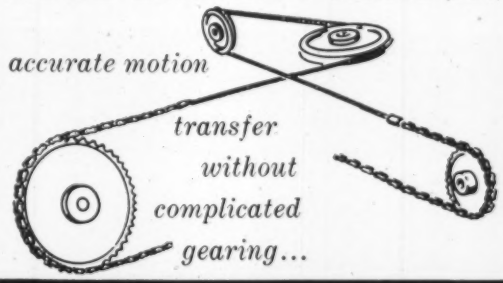


For more information circle **363** on inquiry card.

PRODUCTION-TEST BRIDGE

New "Model AB-3×2 Manual Fed Auto-Bridge" is a low-priced "go-no go" testing instrument which eliminates insofar as possible operator decision and meter reading. One model provides for testing resistors and

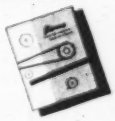
MORE DESIGN FREEDOM



SIERRA MINIATURE MECHANICAL CHAIN AND SPROCKETS...

Provide precise, positive motion transfer through several planes simultaneously with no cable slippage...no complicated gearing. Unlimited center-to-center selection for miniature and sub-miniature assemblies in servo systems, gyro systems, special cameras, electronic equipment, and small precision instruments. Less weight, cost, maintenance —wider tolerances. Designed to operate around minimum 7-tooth sprocket with root diameter of .250 inches. Chain pitch .1475 inches; Weight .45 oz. per lineal ft. Material: stainless steel, or other materials, including non-magnetic beryllium copper.

NEW CATALOG



Contains useful application data, specifications, tables on chain pitch and sprocket sizes, suggestions for calculating center-to-center distance. *Write for yours today.*

123 E. Montecito Avenue, Sierra Madre, California

Sierra ENGINEERING CO.

T. M. REG.

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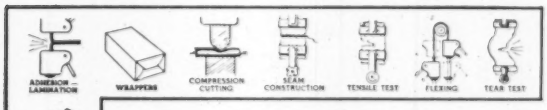

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The many models of Scott Testers have the scope and versatility for application to the testing needs of a wide range of industries within the range of 0 to 1 ton tensile at controlled temperatures from −70°F to +1000°F.

Leader in testing equipment since 1899, Scott has for many years been active in the various Societies for study and development of test methods, indicating exceptional ability to assist your technicians.

Model J—World Standard tester for tensile and elongation tests—available with jaws for many of the tests illustrated.

State your problem —let our 57 years experience assist.

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SCOTT TESTERS **SCOTT TESTERS, INC.**
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PANEL SPACE LIMITED? SPECIFY

DIALCO® 2-Terminal Sub-Miniature Pilot Lights

COMPACT
RUGGED
OMNIDIRECTIONAL PLASTIC DOMES
COMPLETELY INSULATED

Also available with "Taper-Tab" quick-connect terminals

Also

1-Terminal Pilot Lights

for use on grounded circuits. Available with *binding* screw or *soldering* terminal.

DIALCO's expanded line of sub-miniature lights conform to all applicable Mil Specs. Use T-1¾ midget incandescent lamps—1.3 to 28 V. Spring mounted *Lens-with-Message* is readily positioned *after* installation... Mount from *back* of panel in 15/32" clearance hole; or from *front* of panel in 17/32" hole... 7 lens colors... Shown approx. actual size (top to bottom): No. 134-3830-375-6... No. 101-3830-951... No. 101-5030-951... No. 109-3830-111... No. 111-3830-111... No. 107-1930-951.

Complete details in Brochures L-156 A and L-157.

SAMPLES ON REQUEST—AT ONCE—NO CHARGE

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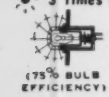
For more information circle **108** on inquiry card.

BRIGHT NEW CONCEPT IN PANEL LIGHTS!

3 Times Greater Light Efficiency



. . . because a new, tiny Alden bulb (only 1/4 the size of miniature bayonet bulbs) is sealed high up in its own translucent lens and mounted in front of the panel to provide maximum indication. that is . . .

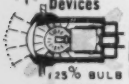
Visible From Any Angle — Any Distance
Lens glows like a red hot poker in a 180° arc.

Non-Refracting — Unobtrusive When Unlit
Even brightest outside lights will not cause false indication

Instantly Replaced From Front Of Panel

Merely drill a .348" hole and snap-in for mounting. Holds fast under shock or vibration. Bulb lens assembly replaces from front of panel.

Eliminates Bulky Focusing or Refracting Devices



Since most conventional indicator light bulbs are located behind the panel they have to make use of bulky magnifying lenses or refracting devices.

Variety Of Colors And Voltages
6V, 12V, 24V, 110-220V Neon

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SCLEROSCOPE
FOR TESTING THE HARDNESS OF METALS. PIONEER AMERICAN HARDNESS STANDARD. OVER 40,000 IN USE.

DUROMETER
FOR TESTING THE HARDNESS OF RUBBER & RUBBER-LIKE MATERIALS (ASTM D676)

SHORE INSTRUMENT & MFG. CO., INC.
90-35 VAN WYCK EXP.
JAMAICA 35, N. Y.

For more information circle **110** on inquiry card.

NEW INSTRUMENTS

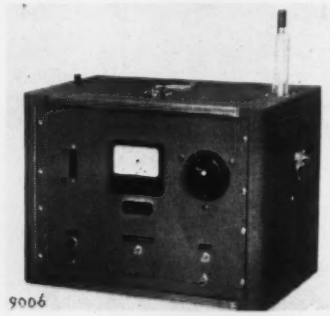
capacitors at a measuring frequency of 1 kc; a companion model is available for testing with dc bridge source. A true limit bridge principle is employed and no setup or calibration adjustments are necessary. High and low tolerance limits are set by means of plug-ins. New unit uses many features of maker's higher priced semi-automatic and automatic equipments, but uses manual feed and lacks sorting mechanisms—*Industrial Instruments, Inc., 89 Commerce Rd., Cedar Grove, N. J.*

For more information circle **364** on inquiry card.

HIGH-VOLTAGE TESTER

New 30,000-vac "Model 4300," first of a completely new line of portable and mobile ac "Hypots," is designed for testing plastics, other insulating materials, and equipment requiring test potentials to 30,000 vac at 1 kva. Its readings are of actual test voltage applied irrespective of transformer regulation. Other features include ARI leakage light with standard setting at 5 ma; and continuously variable output voltage control. ★New "Model 4301," also 30 kv at 1 kva, is especially designed for rack and panel mounting.—*Associated Research Inc., 3758 W. Belmont Ave., Chicago 18, Ill.*

For more information circle **365** on inquiry card.



FM DEVIATION MONITOR

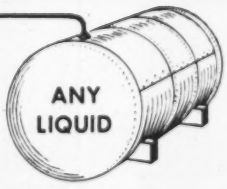
New "Model 791C" features wider modulation frequency range; covers 50 cps to 35 kc at carrier frequencies from 4 to 540 Mc. Deviation ranges 0-5/25/75/125 kc. Instrument uses inherently stable counter type discriminator and accuracy of 3% is achieved by built-in crystal standardization. Harmonic distortion is less than 0.2%. —*Marconi Instruments, 44 New Street, New York 4, N. Y.*

For more information circle **366** on inquiry card.

POWER TRANSIENT ANALYZER

New "TA-120" portable power transient analyzer simultaneously measures, displays and records generator output voltage, frequency, waveform and power, thus directly yields information previously requiring several pieces of equipment and a multistep technique. Any one of four nominal voltages (120, 208, 240, or 416) can be selected for monitoring on

TANK-O-METER
FOR MEASURING TANK CONTENTS ANY DISTANCE AWAY



TANK MAY BE BURIED, ELEVATED, OPEN, CLOSED, VENTED OR UNDER PRESSURE OR VACUUM

SEND FOR BULLETINS

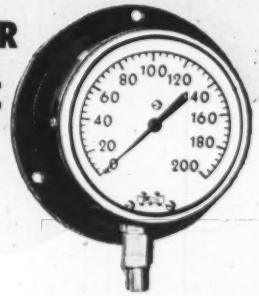
Also gauges for:
Barometric Pressure (Mercury Column)
Absolute Pressure (Mercury Column)
Pressure and Vacuum
Differential Pressure
Inclined Manometers for draft, pressure or differential pressure.

UEHLING INSTRUMENT CO. 470 GETTY AVE., PATERSON, N. J.

For more information circle **111** on inquiry card.

MARSHALLTOWN

THE RIGHT GAUGE FOR YOUR SPECIFIC NEEDS



- PRESSURE
- VACUUM
- COMPOUND
- ALTITUDE
- COMBINATION
- DIAPHRAGM
- HYDRAULIC
- AND SPECIAL PURPOSE GAUGES
- DIAL THERMOMETERS (Vapor Tension or Bi-Metal)

• Available in a wide variety of general purpose and special purpose gauges in pressure ranges to meet your specifications in every particular.

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For more information circle **112** on inquiry card.

OPTICAL COATING LABORATORY, INC.

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SPECIALIZED COATINGS INCLUDING

Dichroic
Multi-layer Anti-reflection
95% Reflectance Front Surface
Electrically Conducting

QUANTITY PRODUCTION OF STANDARD AND SPECIAL COATINGS TO YOUR EXACT SPECIFICATIONS

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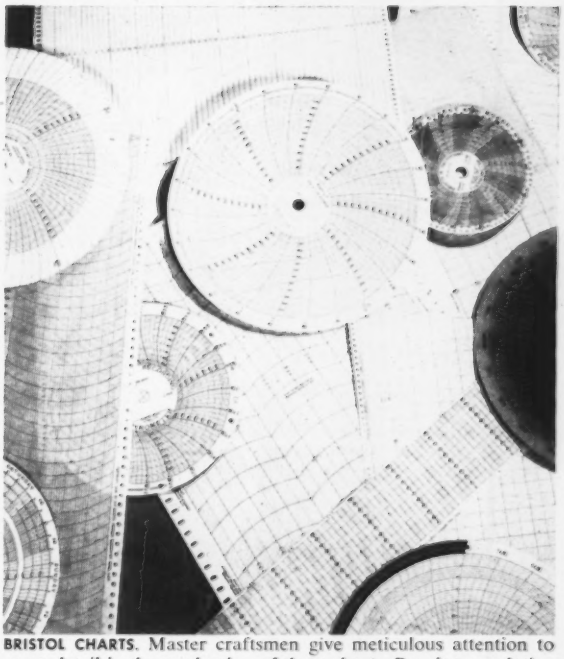


BRISTOL CHARTS. Master craftsmen give meticulous attention to every detail in the production of these charts. Result: superlative accuracy, precision, uniformity.

Charts on short order

Another outstanding Bristol service to instrument men

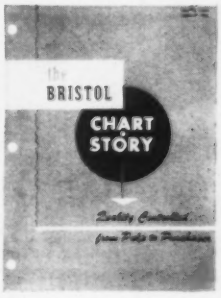
Every year, Bristol turns out hundreds of special strip and circular charts to instrument builder specifications.

It's a service we can offer to scientists, engineers and instrument designers because our recently expanded facilities make us one of the largest chart printers in the country. Naturally, users of this service draw on the know-how we've picked up in 66 years of chart printing for our own precision Bristol instruments.

Strip charts up to 29⅝ inches across, circular charts to 12 inches diameter receive the most meticulous treatment by the most accurate engraving and printing methods known. In addition to regular chart papers of highest quality in various thicknesses, special papers available include: wax coated, heat-sensitive, chemically-coated, electrically-sensitive, or pressure-sensitive papers. Also available: papers for metallic marking, foil-type laminates for extreme dimensional stability, card stock, and carbon coated (smoked) charts can be supplied. We print charts to any mathematical law—linear, square-root, etc.—or with special punchings or perforations.

Take advantage of Bristol's chart service when your recorder is in early design stages, and you'll dodge headaches later on. Write The Bristol Company, 154 Bristol Road, Waterbury 20, Conn.

7.2



HOW ARE BRISTOL CHARTS MADE? Ask for Bulletin Y1904 to find out.

BRISTOL

TRAIL-BLAZERS IN PROCESS AUTOMATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **114** on inquiry card.

Uniflow Springless type 500 air to open—air to close —½" to 6" pneumatic or electric pneumatic

select either type but select . . .

Uniflow

air operated Saunders patent type control valves

In chemical, slurry, water treating and high vacuum installations, UNIFLOW Valves are fast becoming most popular because not only are they low in cost, but highest quality requirements are met and maintained.

Uniflow Air Operated Control Valves employ Saunders patent valve features—the valve that requires no stuffing box or stem packing.

with positioner

without positioner

Why not learn how you can fill your difficult control valve needs quickly—economically.

WRITE FOR BULLETIN 114R

UNIFLOW VALVE CORPORATION

19 Quine St. Cranford, New Jersey

For more information circle **115** on inquiry card.

WALK-IN ROOM

1957 CATALOG NOW READY WRITE

Designed and built for

GREER HYDRAULICS, Inc.

NEW YORK

Walk-in Room interior dimensions—10' x 10' x 8' high. Removable temperature partition. Each of the two sections can be operated at different temperatures. Temperature range —100°F to +400°F.—Altitude —can be built to 100,000 feet or higher.—Separate air lock for entrance of personnel without upsetting altitude run.—Rain in either or both compartments at rate of 4" per hour.—Humidity—20% to 100%. Chamber constructed sectionally for ease of installation.

CHAMBERS

- VACUUM OVENS
- HUMIDITY
- HI or LO TEMP.
- SAND and DUST
- SUNSHINE
- RAIN
- SALT SPRAY
- IMMERSION
- FUNGUS
- AIR CONDITIONING
- DIAPHRAGM EXERCISERS
- LIQUID HOT and COLD BATHS

ENVIRONMENTAL TEST EQUIPMENT

INTERNATIONAL RADIANT CORPORATION

40 Matinecock Ave., Port Washington, N. Y.

For more information circle **116** on inquiry card.

NEW INSTRUMENTS

an expanded scale; accuracy within 0.1% and step response 15 milliseconds between 10% and 90% points when reproduced on recorder capable of greater than 60 cps response. Expanded frequency scales 46-54, 56-64, and 375-425 cps; accuracy within 0.1% and step response about 4 ms. Power: 0 to 300 kva summations of phase currents in 3-phase systems without interruption of service; rated kva can be selected so that full-scale deflection indicates 100% rated power output and lesser deflections represent percentages of rated output; accuracy 1%. Special channel included to record voltage waveform on spring galvanometer.—*Alexandria Div., American Machine & Foundry Co., 1025 N. Royal St., Alexandria, Va.*

For more information circle **367** on inquiry card.

TELEMETERING OSCILLATOR

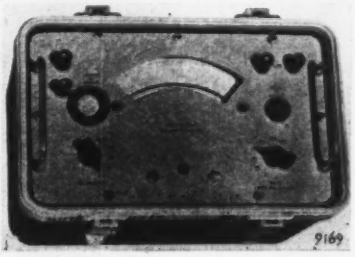
New subcarrier telemetering oscillator features linearity better than 0.5% of full band width over full input range. Stability during variations in filament and plate supply: a 1-v B+ variation produces less than 0.5% full band-width frequency deviation; a 5% filament voltage variation produces less than 1% of full band-width deviation. New plug-in printed circuit filter board permits changing frequency channel of basic oscillator without removing it from service. Thus user can maintain versatility while carrying a smaller number of oscillators in inventory. Additional flexibility is provided by operation on either ac or dc filament voltage; also input level can be adjusted so as to operate either from −1.5v to +2.5v or from 0 to 5 v.—*Dorsett Labs., Inc., 401 E. Boyd St., Norman, Okla.*

For more information circle **368** on inquiry card.

ELECTRICAL INSTRUMENTS

RUGGEDIZED STANDARD ELECTRICAL INSTRUMENTS

New "Ruggedized Reference Standards" not only equal but surpass regular design lab standard voltmeters in sensitivity and accuracy (guaranteed accuracies to 0.25%). They utilize for the first time in elect-

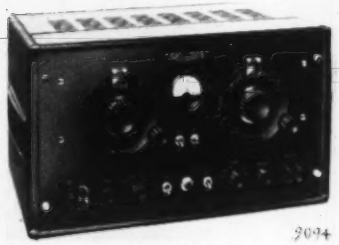


rical-instrument history the combination of diamond pivots and of sapphire jewels mounted on calibrated springs. Instruments will withstand a 3-ft drop on a concrete floor without deformation of diamond pivot or sapphire bearing. Points of diamond pivots are ground to 0.0008" (as against 0.015" steel pivots of high-quality ruggedized panel instruments), whence 18-to-1 advantage in friction factor and no need to "tap" instrument. Service life: after five million full-scale deflections, neither pivots nor bearings showed any significant deterioration.—*Sensitive Research Instrument Corp.*, 310 *Main St., New Rochelle, N. Y.*

For more information circle **369** on inquiry card.

Z ANGLE METER

New "Type 314 Low Impedance Z Angle Meter" features wide range and ease of operation for measuring



low values of complex impedances in polar form. Impedance and phase angle of the unknown are determined by equating its voltage drop to that across a standard impedance of adjustable value, with the same current applied to both. Frequency range 30-1000 cps; impedance magnitude range 0.001-1000 ohms in six steps with 1% accuracy; phase-angle range 90° (lead or lag) with 1% accuracy; dissipation-factor range 0 to infinity.—*Acton Laboratories, Inc., Acton, Mass.*

For more information circle **370** on inquiry card.

THREE-DIMENSIONAL FLUXMETER

New "3-D Flux Meter" is unique: it measures the strength of a magnetic field along each of its three rectangular axes. Moreover, it is equipped with a long thin probe which permits convenient measurements in narrow spaces such as the inside of focusing solenoids of traveling-wave tubes. Range 2 to 1000 gauss in two full-scale settings. Basic sensitivity about 0.2 mv/gauss. Case is about the size of a box of kitchen matches; probe is 12-1/5" long, 0.435" dia, with a scale engraved in centimeters to facilitate field plotting. Weight of entire unit is 2½ lbs. "3-D Flux Meter" is essentially a dc generator. Its sensing elements are two armatures in the form of small measuring coils which rotate at 3600 rpm in the magnetic field being measured. Armatures are driven by a synchro-

ABSOLUTE PRESSURE INDICATOR
... For Precise Vacuum Work

Accuracy: 1/300 of full scale
Sensitivity: 1/500 in *all* ranges
Ranges: 0-50mm Hg. 0-100mm Hg.
0-200mm Hg. 0-410mm Hg.
0-800mm Hg. 390-800mm Hg.
Dial Sizes: 2¾" or 6" diameter for all ranges
Write for Publication No. TP-28-A

WALLACE & TIERNAN INCORPORATED
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY
In Canada, Wallace & Tiernan, Ltd. — Toronto
A-108

HOW TO DETECT 3 PARTS CHLORINE IN A MILLION PARTS AIR

New W&T Solvay Chlorine Detector*
detects as little as 3 p.p.m. chlorine in a continuous air-stream sample. Automatically sets off alarm at higher concentrations.
Write for Publication 50.118

WALLACE & TIERNAN
INCORPORATED
25 MAIN ST., BELLEVILLE 9, N. J.
I-55 *Manufactured under patent license from Solvay Process Div., Allied Chemical & Dye Corp.

For more information circle **117** on inquiry card.

True Hermetic Sealing assures Maximum Stability

in AMPERITE RELAYS and REGULATORS

Simplest • Most Compact • Most Economical

STANDARD

MINIATURE

Thermostatic DELAY RELAYS

2 to 180 Seconds

- Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.
- *Hermetically sealed.* Not affected by altitude, moisture, or other climate changes.
- *SPST only* — normally open or normally closed.

Amperite Thermostatic Delay Relays are compensated for ambient temperature changes from −55° to +70° C. Heaters consume approximately 2 W. and may be operated continuously. The units are *most compact, rugged, explosion-proof, long-lived, and — inexpensive!*

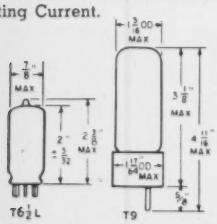
TYPES: Standard Radio Octal, and 9-Pin Miniature

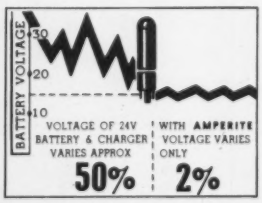
PROBLEM? Send for Bulletin No. TR-81

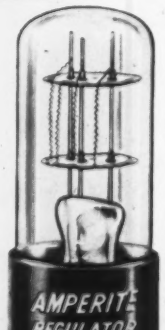
Also — **Amperite Differential Relays:** Used for *automatic overload, under-voltage or under-current protection.*

BALLAST REGULATORS

Amperite Regulators are designed to keep the current in a circuit ***automatically regulated*** at a definite value (for example, 0.5 amp.) ... For currents of 60 ma. to 5 amps. Operate on A.C., D.C., Pulsating Current.







T9 BULB

Hermetically sealed, they are not affected by changes in altitude, ambient temperature (−55° to +90° C.), or humidity ... Rugged, light, compact, most inexpensive.

Write for 4-page Technical Bulletin No. AB-51

AMPERITE CO., Inc.
561 Broadway, New York 12, N. Y.
Telephone: CAnal 6-1446
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50 Wingold Ave., Toronto 10

Individual inspection and double-checking assures top quality of **Amperite** products.

For more information circle **118** on inquiry card.

NEW INSTRUMENTS

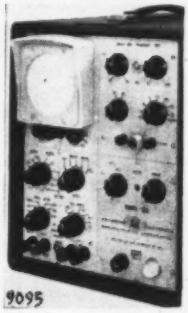
nous motor in meter case and rotate about two perpendicular axes. Voltage induced in each rotating coil is directly proportional to intensity of one of the components of the magnetic field in which it rotates. A special commutator arrangement makes it possible to sense both *X* and *Y* axes of the field with one of the two coils. The second coil is used in sensing the Z axis.—*Federal Telephone & Radio Co., 100 Kingsland Road, Clifton, N. J.*

For more information circle **371** on inquiry card.

ELECTRONIC INSTRUMENTS

MODULAR OSCILLOSCOPE

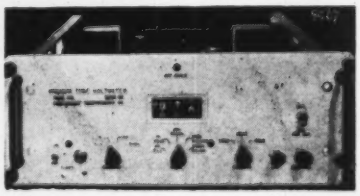
New "Model 200" miniature 'scope offers a variety of combinations of "building blocks": interchangeable amplifiers and sweep generators can be combined with basic CRT and power supply modules to provide general-purpose low-frequency oscillography, HF pulse observation, phase-shift measurement, or other desired applications. Among features: direct-reading amplitude and time calibrations, sweep expansion, and driven and recurrent sweeps; all dc and preamplifier heater voltages regulated.—*Advanced Electronics Mfg. Corp., 2025 Pontius Ave., Los Angeles 25, Calif.*


9095

For more information circle **372** on inquiry card.

AC-DC VTVOM

New "AC-DC Digital Vacuum Tube Voltmeter" reads from 0 to 999, has small indicator lights: "decimal" lights, "plus" and "minus" lights, and an "off-scale" lamp which flashes when measured quantity is larger than register capacity. Dc ranges 0-0.1/1/10/100/1000 v with accuracy of 0.1% of full-scale value; ac ranges 0-0.1/1/10/100/1000 v rms with accuracy of 0.5% from 30 cps to 3 kc and 1.0% from 20 cps to 20 kc; ohmmeter ranges 0-1000/10,000/100,000 ohms and 0-1/10 megs with full-scale accuracy of 0.1%. Full-scale response time about 5 sec. Among features: semi-automatic standardization with an internal Weston type unsaturated

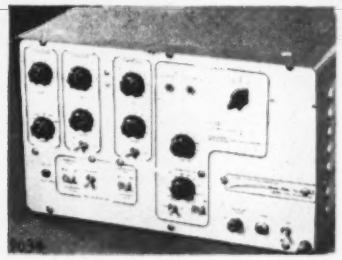


standard cell, push-button operated from the front panel; "Zero-Read-Hold" selector for zeroing instrument and for holding register at any instantaneous reading.—*Performance Measurements Co., 15301 W. McNichols Road, Detroit 35, Mich.*

For more information circle **373** on inquiry card.

PULSE GENERATOR

New "Model 2125 B" features easily accessible internal design combined with simplified circuitry pro-



viding fast rise-time pulses at high repetition rates (to 100 kc). Controls for this improved version of "Model 2125A" provide excellent resolution, utilizing multiple-decade ranges for pulse spacing, delay and width, variable advance or delay operation 0 to 100 usec, variable pulse width from less than 0.1 to 100 usec and variable-amplifier low-impedance output.—*Electro-Pulse Inc., 11861 Teale St., Culver City, Calif.*

For more information circle **374** on inquiry card.

ELECTR-INSTRUMENT ACCESSORIES

DIGITAL DISPLAY

New "In-Line Digital Display Unit" features a unique projection system whereby numbers and/or

characters are displayed on a single one-plane viewing screen. Numbers are of uniform size and intensity, whence optimal readability from any viewing angle. Digits 0 to 9 are 1¼" high and include a shifting decimal point. Units are also available with "+" and "−" and "A.C." and "D.C." Lamp replacement when necessary is made at rear of unit, where all wiring is also located. Displays can be purchased in single units and

NEW 750 WATT Custom

DC to AC CONVERTERS

In answer to a demand for larger capacity DC to AC Rotary Converters, Carter now adds this 750 Watt model to its famous "Custom" line.

Like Carter 300, 400 and 500 watt Converters, this new 750 watt job incorporates the latest technological advances in Converter engineering.

Carter "Seven-Fifty" Converters are available for input voltages of 24, 28, 32, 64, 115 and 230 Volt DC and deliver clean 115v. 60 cycle AC.

"Seven-Fifty" Carter Custom Converters deliver full 115 volts AC under full load conditions while operating at their greatest efficiency. To overcome heavy starting load on major appliances, these converters actually deliver a surge of nearly 1000 watts at 110 volts, 1200 watts at 102v. AC. The full normal 750 watt load being obtained at 115v. AC output. Here is considerable overload capacity available without sacrifice of efficiency, without overheating or damage.

750 WATT DYNAMOTORS ALSO AVAILABLE FOR DC TO DC VOLTAGE CONVERSION.

Carter Motor Co.

Carter Motor Co., 2707 W. George St., Chicago 18
Please send Bulletin 1156A showing New Carter "Seven-Fifty" Converters, with performance chart and complete specifications.

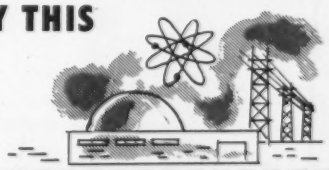
Name

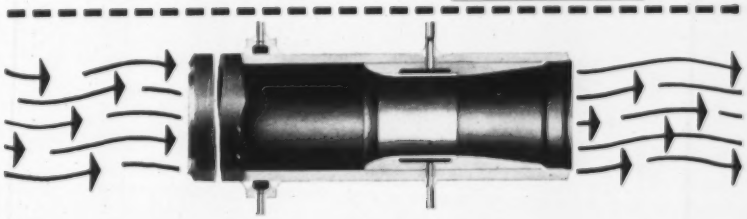
Firm

Address

For more information circle **119** on inquiry card.

PRODUCTIVE ATOMS POSED A "HOT" METERING PROBLEM... SOLVED BY THIS BUILDERS FLOW NOZZLE!!





This Flow Meter is in the primary loop of every major atomic reactor in America — from the Nautilus to the Shippingsport Power Plant.

- Only flow nozzle offering the accuracy, range, low head loss, freedom from upstream disturbances, and other desirable characteristics of the Venturi Tube.
- Built to ASME pressure vessel code.
- Designed for high temperature — high pressure applications (power plants, high pressure lines, atomic reactors, etc.).
- Nozzle can be factory inserted in any customer-supplied high cost, special pipe at considerable savings.
- Completely drainable on modified designs; modified versions excellent for slurries.
- Design based on the most comprehensive compilation of primary element/fluid flow data available anywhere.

Let Builders application engineers solve your flow metering problems.

BUILDERS-PROVIDENCE DIVISION OF B-I-F INDUSTRIES

Write Builders-Providence, Inc., 422 Harris Avenue, Providence 1, Rhode Island

For more information circle **120** on inquiry card.

SUPPORTS FOR TUBING AND CABLE PASS "THE ACID TEST"—

THE APPROVAL OF DESIGNERS, CUSTOMERS, AND USERS WHO SAY: "Well laid out and engineered." "Nicer and sturdier." "Quick and easy to install." "Boy, does that ladder look good." "We're ordering more." "For my money, I'll take P-W supports anytime." "Thanks, for good delivery."

P-W offers the latest in support systems—expanded metal, ladder, or solid—which are interchangeable as required. Comes in 3", 6", 9", 12", 18", and 24" widths, in 1' multiples from 1' to 10', 12' and 16' lengths. Can be purchased in two ways: (1) in certain standard lengths, or (2) in various lengths, which, together with P-W's Extension Connectors, eliminate all field cutting. Adjustable Horizontal and Riser Connectors give the greatest flexibility and meet all changes in direction and elevation. P-W's Channel Connectors, with drive rivets, provide a quick and easy connection.

P-W ladder or trough, both in 1½" and 3" high sides, is used extensively to hold single tubing or multitube. A whole system for single tubing can be laid out by merely ordering various straight lengths and fitting connectors: regular, extension, adjustable and reducing. Radii fittings are available for multitube.

P-W has sharp bend connector fittings—elbows, tees, crosses, risers and straight connectors for 1", 1½", and 2½" Channel Raceway with various size tube clips. Also available: 3" Raceway—Cushion Clamps—Tee Bars—Long Span "I" Sections—Bulkhead Bars. P-W Twist-Rack is used to support Trough or Ladder.

Join our ever-growing list of outstanding and satisfied customers. The first step is to write today for our catalogs. Let our engineers help you.

P-W INDUSTRIES, INC. Duncan & Melrose Sts. Philadelphia 24, Pa.

Representatives Throughout Country To Serve You!

For more information circle **121** on inquiry card.

NEW INSTRUMENTS

in rows of 2, 3, 4, etc. Bezel plates available for single or group units. Voltage is 6 to 7.5 ac or dc.—*Industrial Electronic Engineers, 3973 Lankershim Blvd., N. Hollywood, Calif.*

For more information circle **375** on inquiry card.

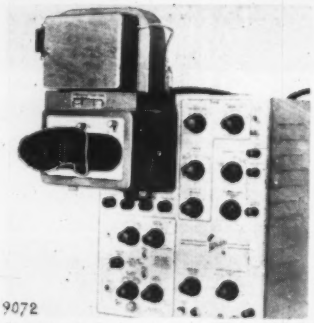
"CORRECT-PHASE" CHOPPER

New "Type 605" chopper obviates need for an *R-C* circuit ordinarily used to bring voltage and output into phase: is designed so that both electrical and mechanical phase lags, inherent in choppers, total 180° at 400 cps. Thus it can be wired exactly 180° out of phase or reversed to be exactly in phase (360° out). Available with side or vertical flange mount; with flattened pierced pins, solder loops or standard socket pins. Coil current 25 ma; impedance 190 ohms; resistance 160 ohms. Phase changed ±10° at constant 400 cps under all conditions of use and life. Noise less than 0.5 mv. rms into 1 meg.—*Oakes Mfg. Co., Dept. U, 1260 Clybourn Ave., Chicago 10, Ill.*

For more information circle **376** on inquiry card.

'SCOPE RECORDING CAMERA

New "Model K-5 Oscillotron Camera Recording System" mounts on all makes and types of portable and

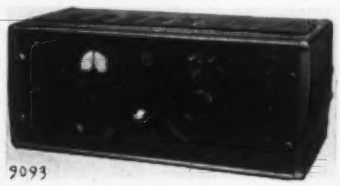


rack-mounted 'scopes without interferring with 'scope controls or other equipment in rack-mounted assemblies. System employs a basic periscope assembly with binocular viewing hood and port through which image can be observed before or during operation. Interchangeable camera and magazine assemblies include 35 mm and 70 mm film magazines for single-frame or continuous strip film operation, and Land-Polaroid cameras for rapid record reproduction. Time-marking and data-recording chambers are available accessories. Systems can be supplied for 115 v ac or 28 v dc operation.—*Photographic Products, Inc., 1000 No. Olive St., Anaheim, Calif.*

For more information circle **377** on inquiry card.

PHASE STANDARD

New phase standard for calibrating phase measuring instruments can be used also with a 'scope to measure



9093

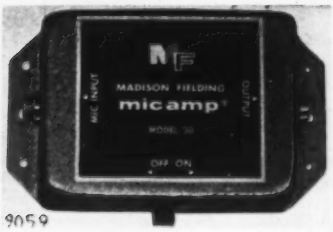
phase shift in electronic circuits or to calibrate precision phase shifters. It converts an externally supplied signal (20 cps to 20 kc) into two sinoidal signals whose phase relationship can be varied from 0° to 360° in four revolutions of a single control. Phase angle accuracy is 1° from 20 cps to 10 kc; 3° from 10 kc to 20 kc. Inherent distortion is less than 1%; over-all distortion depends on externally supplied signal.—*Acton Laboratories, Inc., Acton, Mass.*

For more information circle **378** on inquiry card.

AMPLIFIERS

PREAMPLIFIER

New "Model 30 Micamp" is an all-transistor impedance-matching preamplifier unit for use in all systems



9059

where a low-impedance low-level sound signal source is connected to a high-impedance preamplifier. Will accommodate all signals of about 0.005 uv and all impedances from 2 to 250 ohms. Output signal impedance about 18,000 ohms, with more than 30 db gain. Frequency response flat to 1.5 db from 20 to 20,000 cps; zero hum; "non-measurable" noise and distortion.—*Madison Fielding Corp., 863 Madison St., Brooklyn 21, N. Y.*

For more information circle **379** on inquiry card.

MACHINE SERVO AMPLIFIER

New "MB-1000-60" 1000-watt magnetic servo amplifier for industrial automation features one-cycle response; provides both reference-phase and control-phase power for a ¾-hp motor; makes possible automatic operation of milling machines and other 60-cps equipment or processes that permit programmed operation. It incorporates a Scott-connected transformer and has no toroids. Primarily for 220-v 3-phase operation, it will also provide 115-v single-phase or 2-

do YOU use time delay relays?

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A. W. HAYDON Company

The A. W. Haydon Co. offers a complete line of ADJUSTABLE — HERMETICALLY SEALED TIME DELAY RELAYS for operation under adverse environmental conditions

Write for Bulletin AWH TD401

Bulletin AWH TD401 Describes
6400 Series — DC units
11400 Series — AC units
24300 Series — 400 cycle units
Nominal Range of Adjustment: 8-1
Timers supplied with:
AN connector
Hermetic Adjusting Knob
Glass Window and Calibrated Dial

Illustrated above are a few of the many environmental conditions which these compact timers are designed to withstand. More rigid requirements frequently can be met upon special consideration.

The A. W. HAYDON COMPANY
228 NORTH ELM STREET
WATERBURY 20, CONNECTICUT
Design and Manufacture of Electro-Mechanical Timing Devices

For more information circle **122** on inquiry card.

PREFERRED!
Clary Numerical Data Printers

Clary is the printer preferred by many of America's top companies for data-handling work and automation. For example, in solving such problems as *shaft position* and *digital voltmeter* conversion, the Clary printer is now standardly used by more and more firms. Clary may well be the one printer able to answer your problem.

Gives you a permanent printed record, instead of a fleeting visual one. Both serial and parallel-type printers available. Choice of 4 models, 8 to 11 digit capacity. Designed for use with any automation or data-processing system. Capable of taking input in various forms, manual or remote, and delivering it in equally diverse forms. And only Clary equipment is able to print, add and convert remote input to perforated tape or cards. Also a wide line of other data-handling units for industrial and scientific applications. Please write on your letterhead for facts. Clary Corporation, Dept. IA-57, San Gabriel, California.

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ELECTRONICS DIVISION
CLARY CORPORATION
San Gabriel, California

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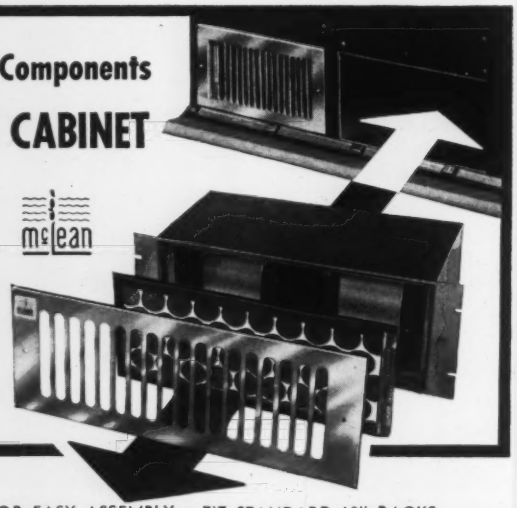
For more information circle **123** on inquiry card.

Save Sensitive Components

COOL THAT CABINET

WITH

McLEAN FANS & BLOWERS*



*Pat. Applied For

RACK MOUNTED FOR EASY ASSEMBLY • FIT STANDARD 19" RACKS

Models Available for 5¼", 7" and 10½" Panel Heights • Wide Range of Air Deliveries

GENERAL FEATURES

- Pressurizes Cabinet With Filtered Air
- Rubber Isolated Motors For Quieter Operation
- Widely Accepted for Use in Military Equipment
- Maximum Air Delivery For Efficient Filter Action

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ADDITIONAL FEATURES FOR BLOWER TYPE UNITS

- Blower Units Provide Better Air Delivery Against Pressure
- Blower Units Provide Quieter Operation Against Pressure
- Higher Air Velocity For Faster Cooling
- Air Flow Maintained With Dirty Filter
- Duct Connections Can Be Made If Desired

Install McLean Fans and Blowers in Computers, Control Systems, etc. They're small, ready to use, packaged units with smart stainless steel grilles and easily replaceable filters. Standard RETMA notching allows mounting on rack without cutting or fitting.

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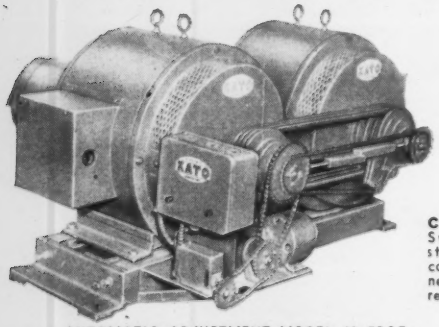
For more information circle **124** on inquiry card.

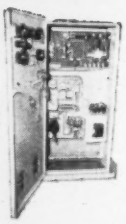
For Better Bench Mock-Up Tests

KATO VARIABLE FREQUENCY MOTOR GENERATOR SETS



REMOTE CONTROL

Remote control frequency adjustment varies speed from 1080 to 1320 RPM, thus varying frequency. Bench mock up test station may be located anywhere.



CONTROL PANELS

Synchronous motor starter and generator controls, including magnetic amplifier voltage regulator in cabinet.

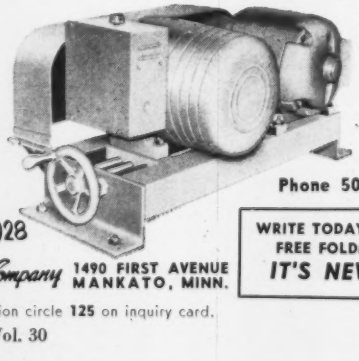
AUTOMATIC ADJUSTMENT MODEL 45 EPOT

Fully automatic variable frequency motor generator set adjusts 360 to 440 CPS. Generator mounted controls include reset buttons, limit switch. Motor and generator remain stationary. Vari-drive pulley adjustment controlled by small motor.

Also, AC Generators, 60 Cycle From 350 Watts to 500 KVA.

MANUAL ADJUSTMENT MODEL 28XA08

Easily adjusted by simple hand wheel controlling variable pitch pulley V-belt arrangement. This motor generator set gives 45 to 60 cps output. Unit holds speed accurately. Frequency meter on generator panel indicates output. Single phase generator speed varies from 1350 to 1950 rpm.



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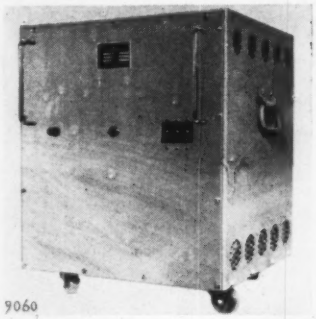
NEW INSTRUMENTS



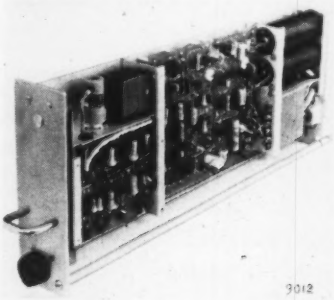
9060

phase operation with simple factory modification. ★New "MB-200" is a 200-watt unit having the same basic features.—*Magnetic Research Corp., 3160 West El Segundo Blvd., Hawthorne, Calif.*

For more information circle **380** on inquiry card.

TUBELESS DC AMPLIFIER

New "Model WN" completely transistorized general-purpose chopper-stabilized dc amplifier is actually a



3012

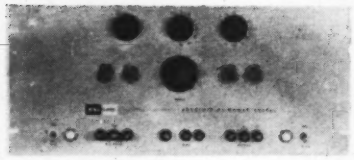
package of four separate amplifiers. Two act as power supplies, producing ±25 vdc. Power transformers in these is completely isolated from earth ground, allowing entire package to "float" relative to ground. Signal passes through two amplifiers: (1) an ac unit that amplifies chopped signal, (2) a dc unit that takes signal after it has been demodulated and filtered. Characteristics include: 2 uv drift in 24 hours at 25°C; 0.01% linearity at dc; output ±15 volts at 100 ma; output impedance 0.02 ohm.—*Beckman Instruments, Inc., 325 N. Muller Ave., Anaheim, Calif.*

For more information circle **381** on inquiry card.

POWER SUPPLIES

DC POWER SUPPLY

New improved "Model 30B-25" provides dc from 1.02 to 302 v at up to 250 ma with 100 parts per million long-time stability 0.01% load regulation factor, 0.002% line regulation factor, and less than 0.5 mv hum and noise. Calibrated dials provide instant selection of desired output voltage to accuracy of 0.02% or 5 mv.

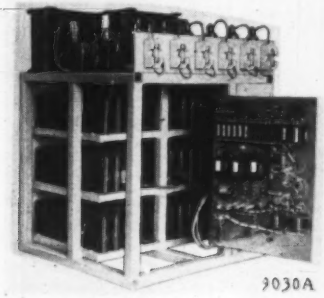


Dc output impedance less than 0.01 ohm; ac output impedance less than 0.5 ohm to 200 kc; response time less than 0.2 ms; front panel connectors provide variable bias from 0 to −150 v at 10 ma and 6.3 vac at 5 amp.—*Kin Tel (formerly Kay Lab), 5725 Kearny Villa Road, San Diego 11, Calif.*

For more information circle **382** on inquiry card.

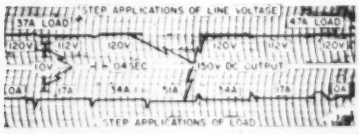
D-C POWER SUPPLIES

New thyratron dc supplies operating from 60 cps line can be furnished for outputs up to 500 v and for loads



3030A

from one to 150 amp. Extraordinary transient performance: 20% step application of load or 5% step change

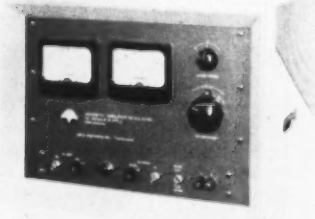


in ac line voltage produces only 0.15% variation in output voltage. Response time 10 ms. Ripple 0.1% peak to peak.—*Dynamic Controls Co., 1955 Massachusetts Ave., Cambridge, Mass.*

For more information circle **383** on inquiry card.

15-AMP POWER SUPPLY

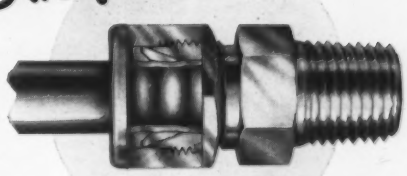
New "Model MR 532-15A" is a light-weight magnetic-amplifier-regulated supply delivering 2 to 36 v at 15 amp; has a voltage range available between 2 and 36 and between 5 and 32; ripple 1% rms; regulation 0.5% over range of 5 to 32 v, 2%



3068

Only one name identifies the finest in fittings

Swagelok®



TUBE FITTINGS

There is a Swagelok Specialist in your area. For catalog, write Dept. A-5.

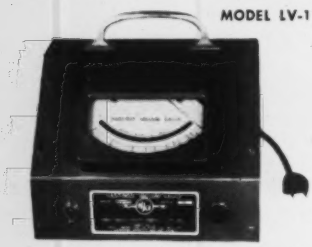
CRAWFORD FITTING COMPANY

884 East 140th Street • Cleveland 10, Ohio

For more information circle **126** on inquiry card.

HASTINGS VACUUM GAUGES

SET NEW STANDARDS OF ACCURACY, STABILITY, RESPONSE



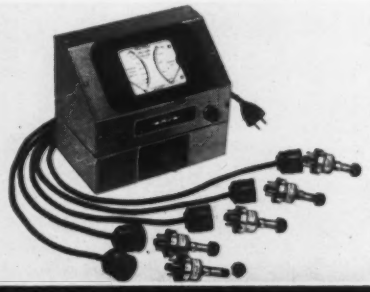
MODEL LV-1

- Easy To Read Scales
- Unusually Long Life
- Matched Gauge Tubes
- No Outgassing Or System Contamination

NEW MODEL LV-1. Measures 0-100 micron Hg. Single meter; large 4" scale indicates vacuum directly without adjustments. Internal voltage regulator takes care of fluctuations in line voltage. Ideal for Industrial Installations. Also available in 0-1000 micron and 0 1-20 mm Hg. ranges.

MODEL GV-3 VACUUM GAUGE

(Shown at right with optional 5-position switching attachment) Range from 0-1000 microns Hg. Manual current set and additional milliampere scale allow adjustment for use in presence of gases other than air, for leak detection, and for specialized laboratory use.



Evaluation by Users

PROVES SUPERIORITY

of Hastings Gauges

WRITE:

HASTINGS-RAYDIST INCORPORATED
HAMPTON 13, VIRGINIA
PHONE 3-6531

For more information circle **127** on inquiry card.

This announcement does not constitute an offering. The offering is made only by the Prospectus, which may be obtained from such of the undersigned as are registered dealers in this State.

April 3, 1957

369,600 Shares

Fisher Governor Company

Common Stock
($1 Par Value)

Price $12.50 per share

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The First Boston Corporation — Hornblower & Weeks

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Kidder, Peabody & Co. Incorporated — Merrill Lynch, Pierce, Fenner & Beane

Stone & Webster Securities Corporation — White, Weld & Co.

Paine, Webber, Jackson & Curtis

For more information circle **128** on inquiry card.

NEW INSTRUMENTS

from 2 to 5 v and 32 to 36 v; max response time 0.1 to 0.2 sec.—*Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.*

For more information circle **384** on inquiry card.

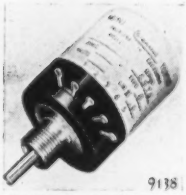
RESISTORS

METAL FILM RESISTOR

New "Types MEC and MEF Metal Film Precision Resistors," available in ½ and 1 watt sizes, have a metallic resistive film firmly bonded to a specially compounded ceramic core; are said to be "designed to combine high accuracy and stability with low and controllable temperature coefficients . . . also provide low noise and negligible voltage coefficient and have low capacitance and inductance which permits their use in high-frequency applications."—*International Resistance Co., 401 N. Broad St., Philadelphia Pa.*

For more information circle **385** on inquiry card.

LOW-TORQUE VDR



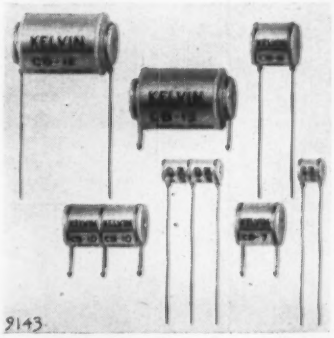
9138

New "Model 85151 Minitorque Potentiometer" is a voltage-dividing resistor featuring 0.003 oz-in torque and heavy-duty 0.125" stainless-steel shaft mounted on miniature shielded ball bearings. Available in resistance ranges from 100 to 100,000 ohms. Withstands high vibration and acceleration.—*G. M. Giannini & Co., Inc., 918 E. Green St., Pasadena 1, Calif.*

For more information circle **386** on inquiry card.

PRECISION RESISTORS

New "Series CB" wire-wound resistors feature tension-free windings said to "practically eliminate resist-



9143

ance drift with age and 'shorts' or 'opens' due to thermal shock." To further insure stability, all windings are heat-cycled and aged. Standard resistance ranges 150 kilohms to 8.0 megohms; operating temperatures −55°C to 85°C. Low inductive effect of reverse-pi wound resistance wire

maintains tolerance up to 30 kc. Standard tolerances 1%, 0.5%, 0.25% and 0.1%.—*Kelvin Electric Co., 5907 Noble Avenue, Van Nuys, Calif.*

For more information circle **387** on inquiry card.

RECTIFIERS

TINY SELENIUM RECTIFIER

New "Siemens Dwarf" 5-ma dc half-wave rectifier will handle up to 125 vac with a resistive load. Assem-

bled in a black plastic body with flat pigtail leads, it is inexpensive and extremely rugged in withstanding vibration and shock. "Siemens Dwarfs" are available only in half-waves, but several units can be connected for other circuits, such as bridge, center tap and doubler.—*Semiconductor Div., Radio Receptor Co., Inc., 240 Wythe Ave., Brooklyn 11, N. Y.*

For more information circle **368** on inquiry card.

RECTIFIER TUBES

New "RCA-6894 and -6895" half-wave mercury-vapor rectifier tubes are for use in high-voltage rectifier circuits designed to supply dc power with good regulation to broadcast transmitters and industrial types of equipment. Their ratings make them companion tubes to "RCA-5563-A" mercury-vapor thyratron. They can withstand maximum peak inverse anode voltage of 2000. Each can deliver max peak anode current of 11.5 amp (average 2.5 amp) in quadrature operation. Both are designed to resist shock and vibration.—*Radio Corp. of America, Tube Div., Harrison, N. J.*

For more information circle **389** on inquiry card.

ELECTRONIC COMPONENTS

TRAVELING-WAVE TUBES

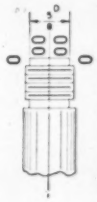
New line of eight traveling-wave tubes, covering the range 2 to 12 kMc, offers a rugged light-weight construction ranging from 5 to 7 lb total weight including a combined capsule and solenoid which not only permits size and weight reduction but also minimizes power requirements for solenoid. Four tubes cover range 2 to 4 kMc with power outputs from 10 to 30 dbm and small-signal gains

The Lepel line of induction heating equipment represents the most advanced thought in the field of electronics as well as the most practical and efficient source of heat yet developed for industrial heating.

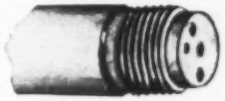
If you are interested in induction heating you are invited to send samples of the work with specifications. Our engineers will process and return the completed job with full data and recommendations without any cost or obligations.

TYPICAL INDUCTION HEATING APPLICATIONS

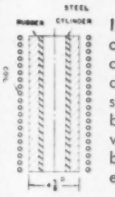
HARDENING DIESEL FUEL INJECTOR



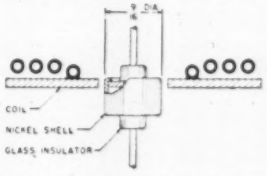
Restriction of heat to end of holder body for fuel injector permits hardening of face to provide required resistance to deformation without hardening the threads. Coil design shown provides uniform temperature for hardening despite holes in face.



REMOVING RUBBER FROM STEEL



Induction heating develops uniform temperature at steel-rubber interface destroying bond for easy separation. Steel and rubber may similarly be salvaged from mounting brackets, shock absorbers, etc.



SOLDERING TRANSISTOR ASSEMBLIES

Concentrator-type coil creates high intensity, restricted heating at joint of nickel shell and tinned glass, thus causing solder flow for permanent seal.

Electronic Tube Generators from 1 kw to 100 kw.
Spark Gap Converters from 2 kw to 30 kw.

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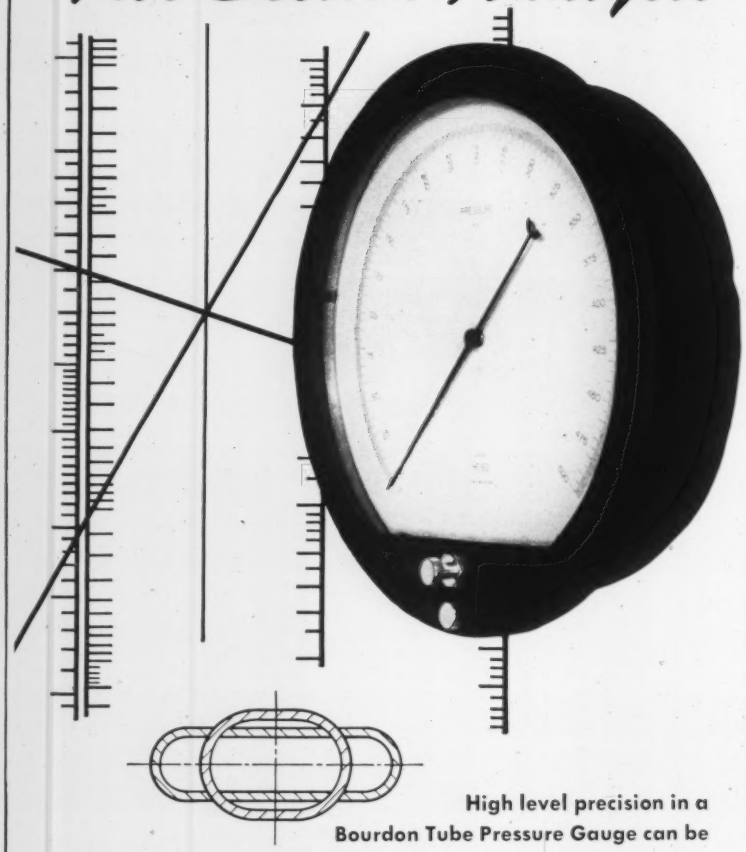
For more information circle **129** on inquiry card.

HEISE GAUGES

Tube Section Analysis



High level precision in a Bourdon Tube Pressure Gauge can be achieved only by scientific design of tube section and scrupulous selection of material.

The Bourdon Tube is a hollow, curved beam acted upon internally by fluid pressure in widely varying degree and affected, in some applications, by broad temperature ranges. Uniform distribution of displacement throughout the gauge range and precise control of induced stress requires individual analysis of each gauge application.

Using data and formulas developed by their own laboratory, Heise engineers specify a length-width ratio, wall thickness and all information for maximum performance in each application of their gauges.

Pressure Ranges 15 to 20,000 P.S.I. Dial Sizes 8½"-12"-16"

Prices from $151.60 **DELIVERY WITHIN 30 DAYS**

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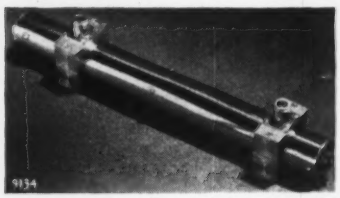


from 28 to 34. Two cover band from 4 to 8 kMc with 10 and 30 dbm outputs and small-signal gains of 30 to 32; two more cover range 8.2 to 12.4 kMc with power outputs of 20 and 30 dbm and small-signal gains of 25 to 30 db.—*Geisler Laboratories, Menlo Park, Calif.*

For more information circle **390** on inquiry card.

POWER TRANSISTORS

Two new transistors of germanium alloy *p-n-p* type: "2N301" designed specifically for audio output stages of mobile communications equipment; and "2N301A" for military and communications equipment requiring operation at peak collector voltages as high as 60. When used in Class A service, either can deliver a maximum-signal power output of about 2.7 w with a power gain of 32.5 db; in Class B push-pull service, two of either can deliver a maximum-signal power output of about 12 w with a power gain of 30 db.—*Semiconductor Div., RCA, 30 Rockefeller Plaza, New York 20, N. Y.*

For more information circle **391** on inquiry card.

N-P-N TRANSISTORS

New *n-p-n* type transistors are now in full production. This type is complementary to the more popular *p-n-p* type: direction of its currents and voltages is opposite to that of *p-n-p*. An *n-p-n*, when used in conjunction with a *p-n-p*, simplifies circuitry, maximizes circuit flexibility, and obviates need of some additional components.—*General Transistor Corp., 130-11 90th Ave., Richmond Hill 18, N. Y.*

For more information circle **392** on inquiry card.

RELAYS

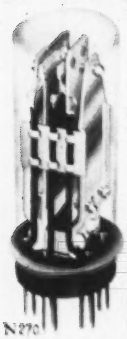
MINIATURE DELAY RELAY

New vibration-resistant miniature thermal delay relay, specifically designed for application in missiles and jet aircraft, features: (1) virtual elimination of contact chatter up to 1500 cps at 10 *G*; (2) no resonance to 500 cps; (3) good ambient compensation between −65°C and 85°C, operation at higher tem-

peratures when necessary; (4) contacts rated for 1 amp at 27.5 vdc or 3 amp at 115 vac. Relays are permanently calibrated before shipment; are available in standard heater voltages and most-specified time delays.—*Instrument Div., Thomas A. Edison Industries, West Orange, N. J.*

For more information circle **393** on inquiry card.

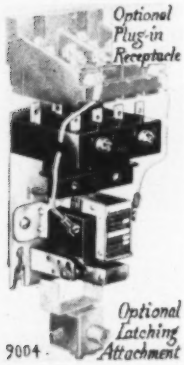
NON-MAGNETIC RELAY



New positive-acting 200-wvdc "Capaswitch" employs, in place of usual electromagnetic coil, two unique electrostrictive ceramic capacitive units called "Capadynes" which transfer the contacts. Electrostrictive ceramic instantly changes its dimensions when subjected to an electric field, bending in the same direction for both positive and negative polarity. Test banks of 100 "Capaswitches" have operated more than fifty million times without "Capadyne" fatigue or failure; tests are being continued. Unit can be actuated by 1 milliwatt-second of energy and pulse as short as 5 microseconds..—*Mullenbach Div. Electric Machinery Mfg. Co., 2100 E. 27th St., Los Angeles 58, Calif.*

For more information circle **394** on inquiry card.

MACHINE-CONTROL RELAYS



New size 0 and 00 relays are said to offer "unusual versatility and adaptability for machine tool control applications"; embody unique new features for simplified installation and maintenance. Size 00 relay is rated at 10 amp 600 vac and the size 0 at 15 amp 600 vac. Two types are offered: "FMP" (fixed multiple pole) and the "IMP" (interchangeable multiple pole). Latter is said to provide "the easiest conversion from normally-open to normally-closed contacts ever devised". Both types are supplied in a complete line with 2, 3, 4, 6 or 8 poles.—*Arrow-Hart & Hegeman Electric Co., Hartford, Conn.*

For more information circle **395** on inquiry card.

MOTORS, etc.

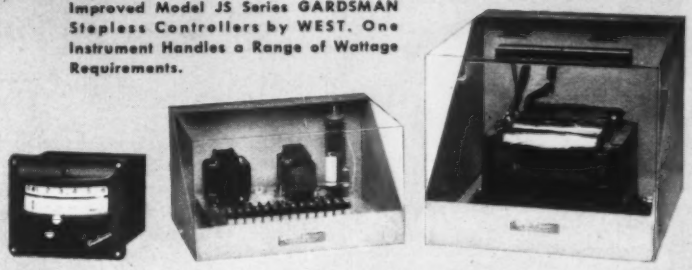
SHADED-POLE MOTOR

New 5" dia shaded-pole motor has 40% lower sound level and is nearly five percentage points more efficient

Stepless temperature Control

NOW! TUBELESS, MULTI-LOAD

Improved Model JS Series GARDSMAN Stepless Controllers by WEST. One Instrument Handles a Range of Wattage Requirements.



★ Closest Control
★ Save power
★ Prolong Heater Life
★ Adjustable Band
★ Manual Reset
★ Simplest Operation—One Knob
★ Least Maintenance

Without tubes or relays, this unique instrument *modulates* input to suit demand. Proved in wide use. Write for Bulletin JS.

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For more information circle **131** on inquiry card.

Portable . . . Versatile . . .
for temperature testing up to 600° F.

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MODEL
TC-4
TEMPERATURE TEST CHAMBER

For ambient temperature tests in the LABORATORY or on the PRODUCTION LINE, the Model TC-4 Temperature Test Chamber is ideal. The wide operating range of the Model TC-4 Test Chamber, from −75°F to +600°F, affords great versatility in testing applications. Interchangeable extra trays may be ordered for greater convenience and elimination of loading delays.

RANGE: −75°F to +600°F.
HEATER: Two 750 watt finned strip heaters.
COOLANT: Dry ice, 15 lbs. capacity.
CONTROL: Adjustable thermostat and selectable heat inputs.
LOAD CAPACITY: 600 cubic inches of test materials.
POWER: 115V, 15 amp., 50-60 cycle.
OVERALL SIZE: 48" x 16½" x 12".
WEIGHT: 62½ lbs.

$700.00
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LOS ANGELES

Statham
DEVELOPMENT CORPORATION
12411 W. Olympic Blvd.
Los Angeles 64, California

For more information circle **132** on inquiry card.

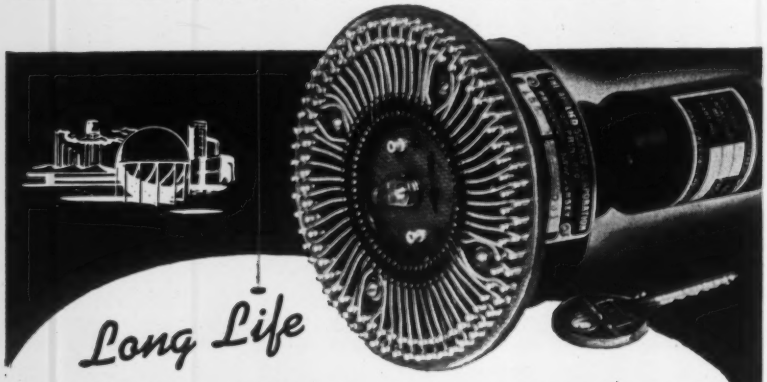
Chroluminum* Coating by Evaporated Protects Delicate Control Instrument

Leeds & Northrup Co. of Philadelphia solved a critical problem in their Rayotube® heat radiation measurement and control device with Evaporated mirror coatings. Radiant energy, entering through the window on the front, is reflected by a double mirror system back to a thermopile, which translates relative heat levels into voltage which can be measured by control instruments. A circular Chroluminum* coating and a precision-coated (±0.005 tolerance) ring on the outside diameter of the glass accurately controls the area through which heat may enter the device. A coated secondary mirror focuses energy from the primary mirror onto the thermopile. "The coatings are of excellent quality," says Leeds & Northrup's inspection department. "We are very pleased with the results." Evaporated's experienced engineers may be able to help you with your instrumentation problems, too. Write us, outlining your needs.

* *Send for free folder describing Chroluminum and other Evaporated coatings.*

EVAPORATED METAL FILMS CORP.
Ithaca, New York

For more information circle **133** on inquiry card.



Long Life

ASCOP SAMPLING SWITCHES

For Automation and Control Applications

ASCOP, the leading manufacturer of rotary sampling switches, for industrial, scientific and military uses, has over 200 standard models for automation, instrumentation, telemetering, display and countless other applications.

ASCOP switches feature reliability, accuracy and trouble free operation. Up to 240 contacts per pole are available. Whether your problem requires a standard switch or a special design, rely on the leader . . .

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For more information circle **134** on inquiry card.

NEW INSTRUMENTS

than previous model. Rated from 25 mhp through 1/12 hp, it is designed for applications where minimum maintenance, quiet operation, and extended life are essential.—*General Electric Co., Schenectady 5, N. Y.*

For more information circle **396** on inquiry card.

AC MOTOR GENERATOR

New size 10 ac motor generator offers minimum length and weight, features cast rotor construction. Applications include error rate damping in servo systems for high stability. Motor control phase voltage 0 to 26; max current per phase 185 ma; no-load speed 7000 rpm; stall torque 0.33 oz-in. Generator main phase voltage 10 v 400 cps; output 0.16 v per 1000 rpm; input power 0.2 watt.—*Clifton Precision Products Co., Inc., Marple at Broadway, Clifton Heights, Penna.*

For more information circle **397** on inquiry card.

CONNECTORS, etc.

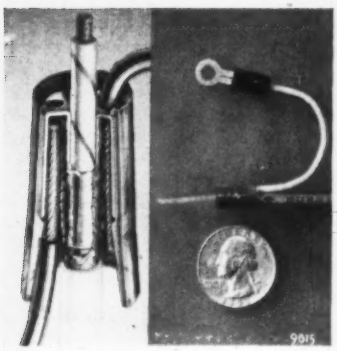
5-WAY BINDING POST

New 5-way binding post, available in two models for plug-in connection of 0.080" test prod or standard ¾" banana plug, features exclusive spring pin contact; provides for five types of connection: (1) wire lead looped around shaft and clamped; (2) wire lead inserted through hole in shaft and clamped; (3) alligator or clip lead fastened to shaft; (4) spade lug inserted around shaft and clamped; (5) either banana plug or 0.080 prod (depending on model used) plugged into jack in knurled thumb screw. Available from stock in black or red (other colors on special order). New unit has passed 250-hr humidity test at 40°C.—*Raytheon Mfg. Co., 100 River St., Walthain 54, Mass.*

For more information circle **398** on inquiry card.

CABLE TAP CONNECTOR

New "Uniring" fully-insulated one-piece tap connector for shielded or coaxial cable minimizes installation time; comprises a one-piece combined inner and outer ring and nylon insulation. Inner ring slides under shielded braid as tap wire is held be-

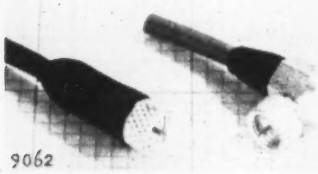


tween braid and outer ring. Inner ring remains unaffected by crimping. Single or multiple taps, from either front or back of connector, can be accommodated. Nylon insulation is color-coded for size identification and extends beyond both ends of "Uni-ring," eliminating metal-to-metal contact and preventing wire chafing in tight locations.—*Burndy Corp., Norwalk, Conn.*

For more information circle **399** on inquiry card.

MINIATURE COAXIAL PLUGS

Two new miniature coaxial plugs, "32-66" and "32-68," designed for new all-Teflon "RG-195/U" mini-



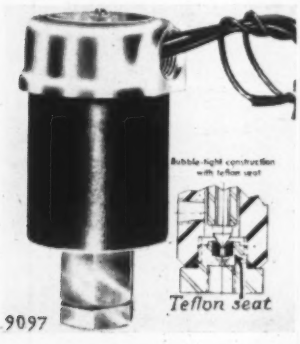
ature coax (0.155" max O.D.) assemble to cable without special tools; mate all maker's existing "S-93" receptacles. "32-66" has a guarded center pin.—*Microdot, Inc., 220 Pasadena, Ave., South Pasadena, Calif.*

For more information circle **400** on inquiry card.

VALVES, ACTUATORS

HP SOLENOID VALVE

New "Type SBTDW" solenoid valve, bubble-tight even at 5,000 psi working pressure, is a small direct-lift angle type machined from 316 stainless steel bar stock, featuring a



+ 0.00
− 0.00

• • • tolerance

Without quibble or qualification, a Meriam Manometer delivers perfect reproducible accuracy. This accuracy is absolute . . . no plus, no minus. Right on the button.
The same differential will always produce the same column height. Not close to the same height, but exactly the same height.
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In a manometer, perfect reproducibility is inherent. It is routine . . . effortless.
How closely do you wish to "read-out" this perfect reproducibility? There are over one thousand different Meriam Manometer forms to answer this question. Sensitivity is selective, depending on the indicating fluid used. For example, one form of Meriam Inclined Manometer, using water, will provide graduations a full tenth of a linear inch apart, equal to 0.0005 psig.
Most important, Meriam has placed this perfect reproducible accuracy at the disposal of the plant operator as well as the lab technician. Rugged models serve along process lines outdoors as well as on central control panels.

NEW

. . . complete and informative guide to manometer theory and practice as well as manometer models for plant, field and laboratory use. Just ask for Bulletin G-14. The Meriam Instrument Company, 10920 Madison Avenue, Cleveland 2, Ohio.

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For more information circle **135** on inquiry card.

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With novel rapid change of magnification from 6x to 160x with wide-angle oculars.

Large working distance from 3¾-in., with diameter of object field up to 32mm. Beyond 80x magnification, the working distance is 1⅝-inch.

Uniform sharpness over the entire field of view. Erect, non-reversed image. Outstanding plasticity; easy on the eyes even during prolonged observation.

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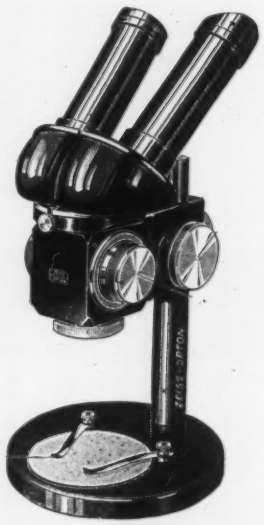


MADE IN WEST GERMANY

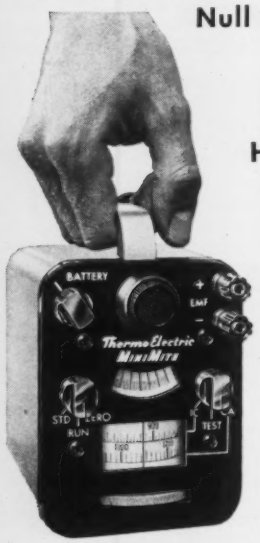
For more information circle **136** on inquiry card.

NEW, Pyrometer Indicator

Null Balance, Potentiometer Type

MINIMITE

Has 23½ Inch Double Scale



Small Size Extremely small and compact, this null balance Portable Potentiometer Indicator weighs under four lbs. and measures only 4" x 5" x 6".

Scale Range Despite its small size the "MiniMite" has a 23½ inch double range scale. There are 15 available scales for all standard thermocouple materials. These scales include temperature ranges from −300°F. to +3200°F. and millivolt ranges from 0 to 62. Measuring accuracy is ¼ of 1% of scale range.

Dual Application The "MiniMite" can measure temperature directly when connected to a thermocouple, or check other potentiometer or millivoltmeter-type instruments when used as a calibrating instrument.

Write for Bulletin 64-F.

Thermo Electric Co., Inc.
SADDLE BROOK, NEW JERSEY
In Canada—THERMO ELECTRIC (Canada) Ltd., Brampton, Ont.

For more information circle **137** on inquiry card.

newly-designed Teflon seat which eliminates metal-to-metal seal and assures bubble-tight operation even with such elusive gases as helium, nitrogen and carbon dioxide. Pipe sizes ⅛" and ¼" with $\frac{1}{16}$", 3/32", ⅛" or $\frac{3}{16}$" port sizes.—*Atkomatic Valve Company, Inc., 545 W. Abbott St., Indianapolis 25, Ind.*

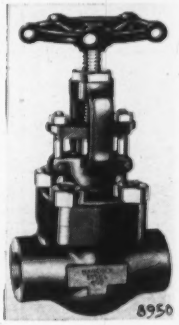
For more information circle **401** on inquiry card.

H-P NEEDLE VALVES

New high-pressure forged steel needle valves, specifically designed and manufactured for high-pressure chemical and petroleum service, feature "Safety Bonnet" design to meet the most exacting safety requirements in throttling, gagging or sampling services. Available from stock in ¼", ⅜", ½" and ¾" sizes.—*August Spindler and Sons, 244 Mercer St., Jersey City 2, N. J.*

For more information circle **402** on inquiry card.

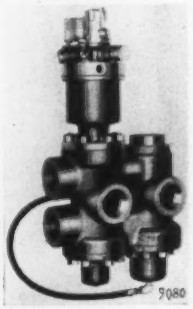
600-PSI STEEL VALVES



New "Type 5520" 600-psi bolted bonnet steel valves with integral or renewable seats are available in globe, angle, check, "Flocontrol" and high-pressure-drop designs; feature OS & Y bonnet with "Flexitallic" gasketed joints and stainless steel swing bolts, nuts, thread bushings and packing gland followers. All have 300-Brinell Type 316 stainless steel stems.—*Manning, Maxwell & Moore, Inc., Watertown, Mass.*

For more information circle **403** on inquiry card.

4-WAY HYDRAULIC VALVES

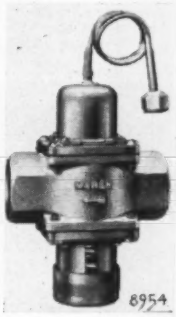


New "Series E-400-X" 3000-psi semi-automatic 4-way hydraulic valves, especially designed for die-casting industry, provide leak-free operation with water, glycol or oil-base hydraulic fluids. Actuated by an integral double-acting cylinder

controlled by a "Speed King" single- or double-solenoid pilot-operated valve, they offer operating safety because they will not reverse in case of air or electrical supply failure. Corrosion-resistant materials are used throughout. Cast Navy "M" bronze bodies; replaceable seat sleeves; Stellite seats. Available in 1", 1½" and 2" NPT sizes, for line pressures up to 3000 psi. 60 to 125 psi air is used for valve actuation.—*Sinclair-Collins Valve Co., 454 Morgan Ave., Akron 11, Ohio.*

For more information circle **404** on inquiry card.

WATER REGULATING VALVE



New 1" pressure-actuated condensing water regulating valve has been added to "56 Series"; is designed with exceptionally wide continuous adjustment range of 60 to 270 psi permitting its use on Freon 12 or Freon 22 systems as well as all other common refrigerants except ammonia. Sizes: ⅜", ½", ¾" and 1". All adjustments can be made by hand. Valve can be mounted in any position without mounting brackets.—*Marsh Refrigeration Equipment Co., 3501 West Howard St., Skokie, Illinois.*

For more information circle **405** on inquiry card.

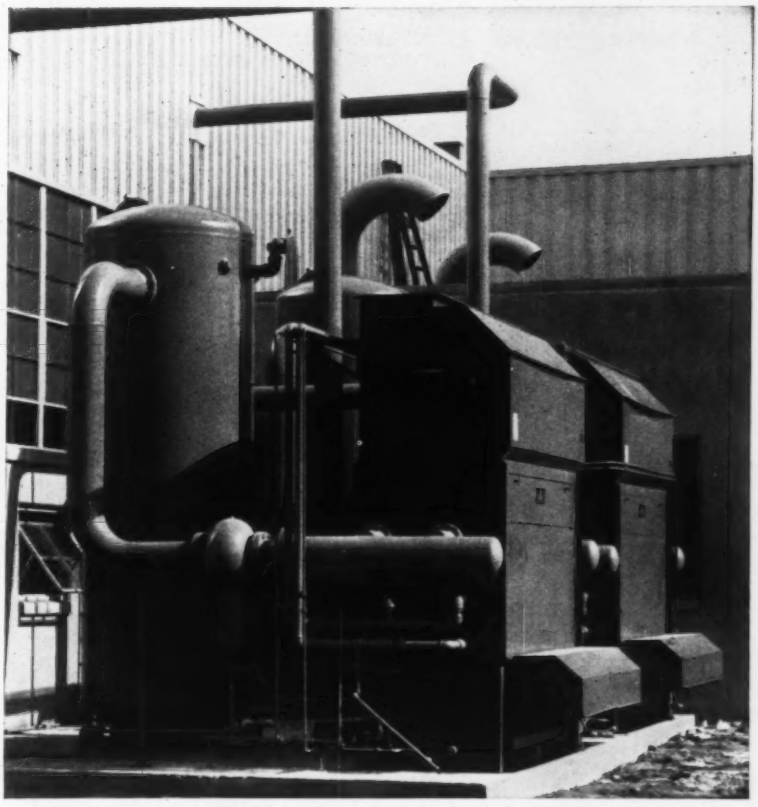
10,000-PSI VALVE

New "Shear-Seal" shut off valve rated at 10,000 psi for liquid or gases will withstand surges of up to 15,000 psi without damage, is designed for a burst pressure of 40,000 psi. Available for pipe, tube, AND 150, or any preferred special high-pressure connection.—*Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.*

For more information circle **406** on inquiry card.

SOLENOID PILOTS

New "Speed King" solenoid pilots feature continuous internal cooling of solenoid coil and self-cleaning effect of actuating plunger to prevent overheating and assures multi-million-cycle trouble-free service life. Normal leak-free service life in excess of 25 million cycles is said to be attained



This Niagara Aero After Cooler also cools compressor jacket and intercooler water.

COMPRESSED AIR... Lower in Cost Dependably Drier and Cooler Trustworthy for Instrument Use

THE NIAGARA *AERO* AFTER COOLER offers a completely self-contained method replacing both shell-and-tube cooler and cooling tower. It is independent of a large supply of cooling water and consistently reduces compressed air temperatures to below ambient. Its drier air gives you a better operation and lower costs in the use of all air-operated automatic instruments, tools and machines, paint spraying, sand blasting and moisture-free air cleaning.

Direct saving in the cost of cooling water saves the price of the Niagara *Aero* After Cooler in less than two years. Water saving also means less expense for piping, pumping, water treatment and water disposal, or you get the use of water elsewhere in your plant where it may be badly needed.

Niagara *Aero* After Cooler assures all these benefits because it cools compressed air or gas below the temperature of the surrounding atmosphere; there can be no further condensation in your air lines. It condenses the moisture by passing the air thru a coil on the surface of which water is evaporated, transferring the heat to the atmosphere. It is installed outdoors, protected from freezing in winter, proven in service on the largest plant utility air systems.

Write for complete information; ask for Bulletin No. 130

NIAGARA BLOWER COMPANY

Over 35 Years of Service in Industrial Air Engineering

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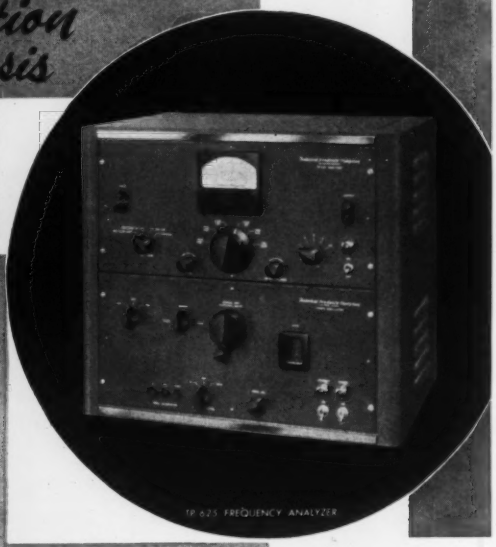
District Engineers in Principal Cities

For more information circle **138** on inquiry card.

FOR *Vibration analysis*

THE TP-625 FREQUENCY ANALYZER



FEATURES

- **LINEAR FREQUENCY CALIBRATION** Manual or Automatic Sweep
- **EXCELLENT STABILITY** Temperature Controlled bridge-stabilized oscillator
- **CONSTANT FREQUENCY BANDWIDTH** As narrow as 2 cps; as broad as 300 cps
- **DYNAMIC RANGE** As great as 66 db (depending upon filter employed)
- **SPECTRUM** 2 cps to 25,000 cps
- **MULTICHANNEL ANALYSIS** Simultaneous analysis of numerous channels

The TP-625 Frequency Analyzer will determine the recorded frequency-amplitude spectrum of a random wave within the frequency range of 2 cps to 25,000 cps. In addition to analyzing random waves, the instrument will also determine the frequency and amplitude of the individual components in a periodic wave within this frequency range.

Wave components resulting from vibration, pressure, strain, light, etc., can be measured in decibels, in percent of total signal or both. Results are indicated on a calibrated attenuator and on a meter. For permanent, detailed analysis, high and low impedance output are provided to drive a recorder. When equipped with its accessory servo system, the TP-625 will follow RPM, or multiples of RPM, in engines throughout an operating range.

For specifications and further information, write for bulletin 625-1-956

Technical Products Co.
INSTRUMENT DIVISION
6670 Lexington Ave. Los Angeles 38, Calif.

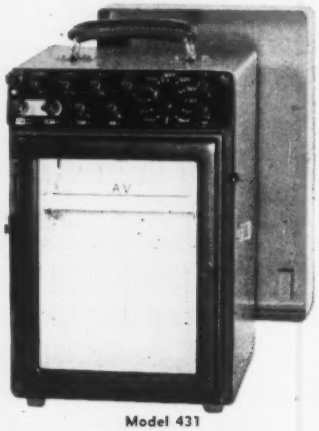
For more information circle **140** on inquiry card.

New 20 Range RECORDER

From Norma of Vienna

This portable precision instrument weighs only 30 pounds and is 8½" x 12"

Scale length is about 5"
Accuracy—1½%



Model 431

Range and consumption

	DC					AC				
Range	AMP	0,015	0,15	0,3	1,5	6	0,015	0,06	0,3	1,5	6
Consumption	VA	0,01		0,02		1	0,15		0,2		0,5

DC Voltage 60mV -6-30-150-300-600V AC Voltage 30-150-300-600V

Fast delivery on all orders . . .

This and other precision meters from Norma of Vienna distributed by—

Dealership Inquiries Invited

OLTRONIX CO.
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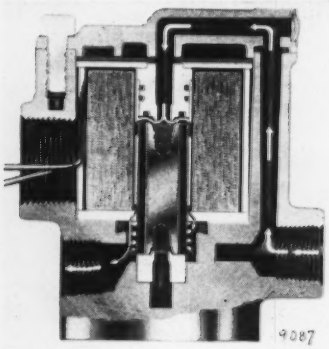
For more information circle **141** on inquiry card.

NEW INSTRUMENTS

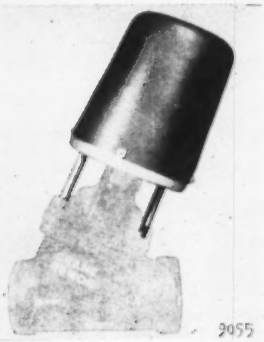


through use of stainless steel seats, plunger and plunger spring. Plunger and spring are the only moving parts. New solenoid pilots, capable of handling air, vacuum, oil, water and inert gases, for direct, sub-base or manifold mounting, are available in 2- and 3-way types for separate pilot control applications. Coils are supplied for 3 to 300 vdc and 6 to 550 vac 25 to 60 cps. Coil current consumption 0.2 amp @ 115 v.—*Valvair Corp., 454 Morgan Ave., Akron 11, Ohio.*

For more information circle **407** on inquiry card.

VERSATILE VALVE ACTUATOR

New "Valvetrol" all-electric rotary valve controller, designed for mounting on valve stem at factory or in the field, provides remote or automatic valve operation with proportional or on-off control. Essentially it is a self-contained gearmotor with hollow output shaft that receives valve stem. Stem diameters from ¼"



to 1" can be accommodated. "Valvetrol" incorporates a voltage-dividing resistor which can provide remote indication of valve position or which can be used as an arm of a balanced bridge control. Units can be furnished to provide follow-up accuracies to 0.04%; standard low-cost units provide accuracy of 0.2%. Units mount on valves of all leading manufacturers. Note that illustrated "Valvetrol" is mounted on Crane diaphragm valve stem; that torque rods are extensions of studs holding valve bonnet to body; and that "Valvetrol" is mounted with a hex stock adaptor so that valve can be turned by wrench in event

of power failure. Wide variety of gear ratios and motors.—*The Jordan Co., Inc., 3235 W. Hampton Ave., Milwaukee 9, Wis.*

For more information circle **408** on inquiry card.

LABORATORY EQUIPMENT

CHROMATOGRAPHIC REFRACTOMETER

New Chromatographic Refractometer is said to cut research time up to 75%. In many cases it "does all

9071

the work . . . Simply start the test, and the analysis is made automatically unattended." Exclusive feature: when off-scale readings are encountered, range-extension system permits setting indicator on scale without annoyance of changing cells, without upsetting the zero calibration and without loss of sensitivity or accuracy. Instrument is of null type; is designed for continuous operation on 115 vac.—*Phoenix Precision Instrument Co., 3803-05 N. 5th St. Philadelphia 40, Pa.*

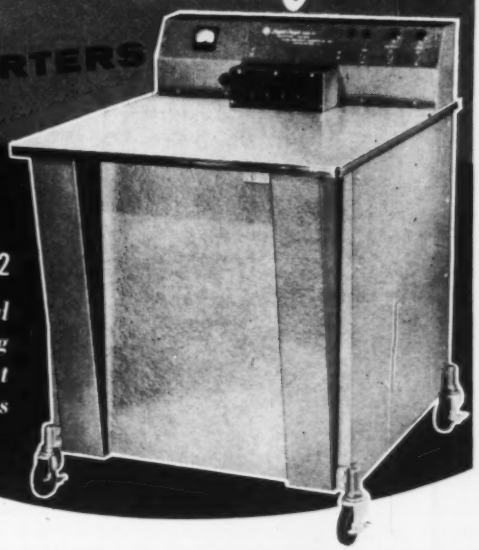
For more information circle **409** on inquiry card.

HIGH-SENSITIVITY PORTABLE MASS SPECTROMETER

New "Type 21-611 Mass Spectrometer" enables analyzing extremely small amounts of gaseous mixtures, or liquids capable of being vaporized; is inexpensive; is designed for both

9116

from Magnet Charger HEADQUARTERS



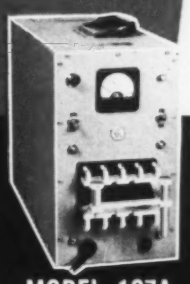
MODEL 942

Recommended by Leading Magnet Makers

3 VERSATILE MODELS

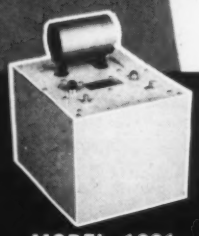
For saturating Alnico magnets weighing up to 34 lbs. and high flux ceramic magnets of any shape or pole configuration. Operates on condenser discharge principle from regular 115-volt, 60-cycle line.

Charging outputs from 100,000 to 200,000 ampere-turns through plug-in transformers, up to 3600 watt-seconds using wire-wound fixtures. Adapters for multi-pole rotors, rod, bar, ring and various other shapes available. Designed for continuous production use with low power consumption. Price of basic unit is less than $2100.



MODEL 107A

A basic condenser discharge unit for most medium size magnets, the Model 107A provides ranges of 12,000 and 24,000 ampere-turns. It is capable of saturating most instrument magnets, including the new core type mechanisms, using adapters or wire-wound fixtures. Designed for continuous duty. Operates from 115-volt, 60-cycle line. Price $530.



MODEL 1221

A low cost, condenser discharge unit employing novel, plug-in wire-wound type charging fixtures, the Model 1221 is designed for the user of small magnets. Its 10,000 ampere-turn output will saturate about 2" of Alnico V. Charging cycle rate is approximately 3 seconds, continuous duty, operates from 115-volt line. Price $180.

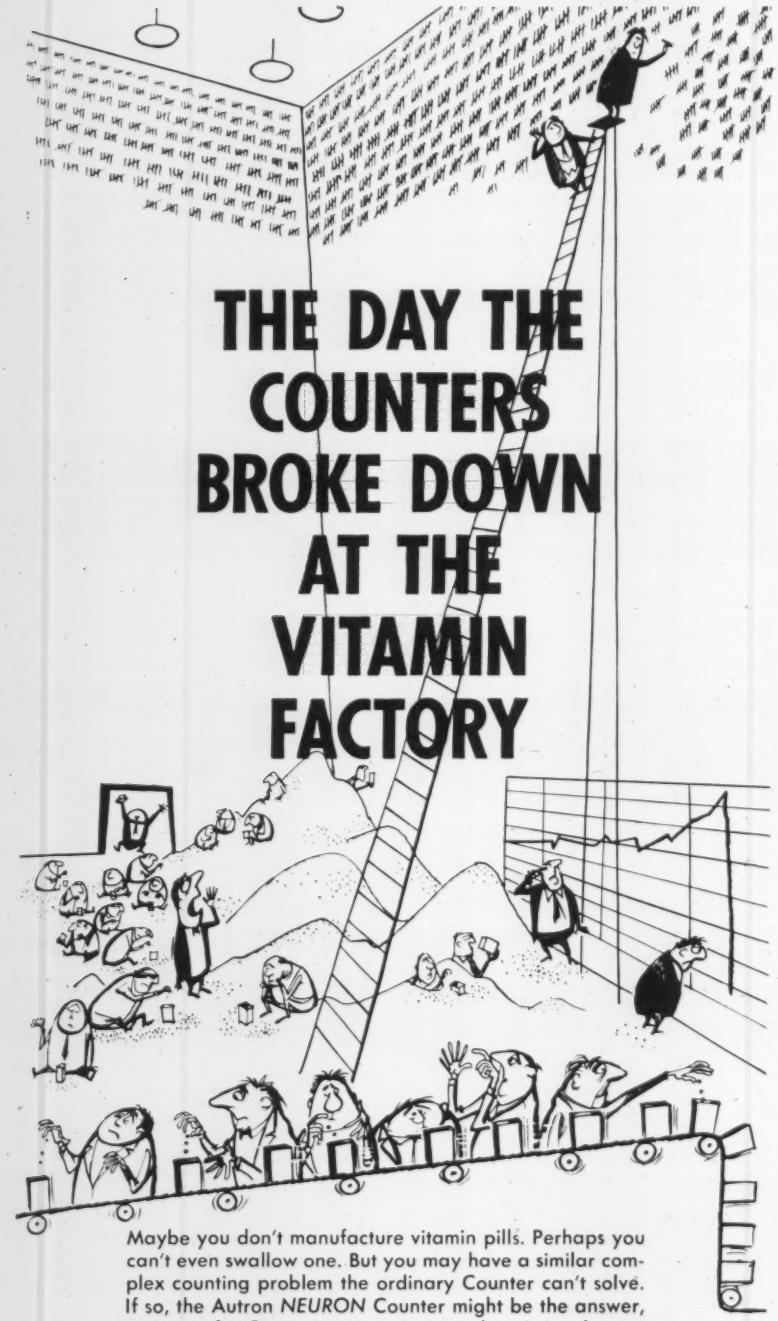
Performance of all models is rigidly guaranteed. Prices are net f.o.b. Boonton, N.J. and subject to change without notice.

WE CAN HELP YOU

12 years' magnet charging experience is yours for the asking—send for illustrated data sheets.

RFL Radio Frequency LABORATORIES, INC. Boonton, New Jersey, U.S.A.

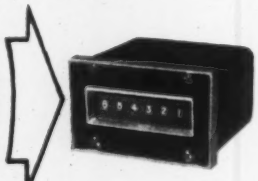
For more information circle **139** on inquiry card.



THE DAY THE COUNTERS BROKE DOWN AT THE VITAMIN FACTORY

Maybe you don't manufacture vitamin pills. Perhaps you can't even swallow one. But you may have a similar complex counting problem the ordinary Counter can't solve. If so, the Autron *NEURON* Counter might be the answer, as it was for Operation Vitamin (see above). It subtracts as well as adds (see below).

The "NEURON" counters epitomize the most advanced electro-magnetic counter technology, featuring high speed (to 60 PPS), long life (in excess of 300 million cycles), pulse reset, switch readout, bi-directional drive (add and subtract), and small size. These precision units may well be the answer to your tabulation problems.



Autron ENGINEERING, INC.

For further information, write to Irwin Aldrich, 1254 WEST SIXTH STREET LOS ANGELES 17, CALIF. *Offices in major cities*

For more information circle **142** on inquiry card.

NEW INSTRUMENTS

lab and plant use. Over-all mass range is from 2 to 80 with resolving power adequate for separation of adjacent peaks up to about mass 35. Unique improved scanning feature: mass numbers appear linearly with time on a large, motor-driven dial, making mass marking unnecessary, since mass numbers appear equally spaced on a fixed time base. Manual override permits operator to turn quickly to any mass number of interest, or to start and stop automatic scan at any desired point. Unique metal rotary valve simplifies batch sample introduction. Errors in settings cannot damage "21-611," thus permitting inexperienced personnel to operate it. Modular design permits control unit to be separated from analyzer unit.—*Consolidated Electrodynamics Corp., Pasadena, Calif.*

For more information circle **410** on inquiry card.

LAB POWER SUPPLY

New "Model D1-100B" power supply for precision laboratory measurements provides two output voltages, 1

9025

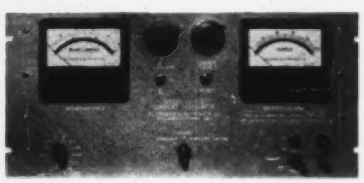
to 100 vdc each, both linear throughout entire range—an exclusive feature. Output voltage is set by means of a 10-turn "Multipot" with inner dial scaled accurately for 0.1-v increments. Current is 0-100 ma, with no derating necessary. Outputs can be pulsed with square-wave load without affecting normal 20-mv regulation. Ripple under worst conditions is below 1.5 mv rms.—*Dressen-Barnes Corp., 250 N. Vinedo Ave., Pasadena, Calif.*

For more information circle **411** on inquiry card.

NUCLEONICS

ACCELERATOR CURRENT INTEGRATOR

New "Model CI-100" is said to be "the first commercially-available accelerator current integrator for users of nuclear particle accelerators." It features high current sensitivity, wide range, and high accuracy. It employs a true current sampling technique which eliminates high impedance input circuits and resulting leakage-

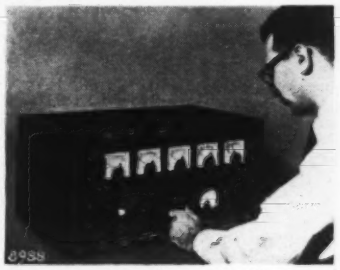


insulation problems. Current measurements of 1 millimicroampere to 1 milliampere and charge measurements of 15 millimicrocoulombs to 29 coulombs can be made with an accuracy of 1% through use of analog computer-type operational amplifiers.—*El Dorado Electronics Co., 1401 Middle Harbor Rd., Oakland 20, Calif.*

For more information circle **412** on inquiry card.

REMOTE MONITOR SYSTEM

New "Model 450" multichannel radiation monitor system for personnel safety has a basic five-channel master

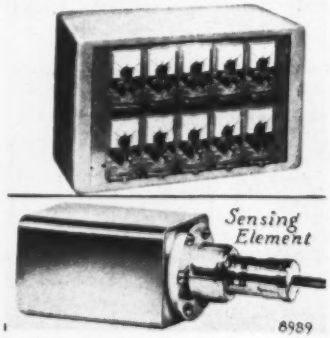


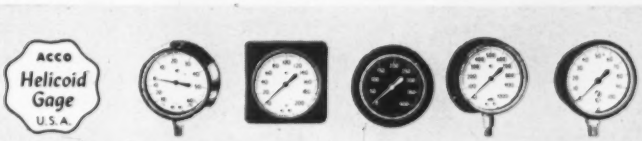
console; can monitor radiation up to several thousand feet away in each of five different locations. Automatic alarm obviates need for anyone to watch indicators. Monitor operates efficiently with a wide variety of maker's GM probes and scintillation detectors, including especially designed alpha, beta, gamma, and neutron detectors. Standard rack mount can be stacked to centralize 10, 15, 20 or more monitoring channels.—*Universal Atomic Corp., 143 E. 49th St., New York 17, N. Y.*

For more information circle **413** on inquiry card.

REMOTE MONITOR SYSTEM

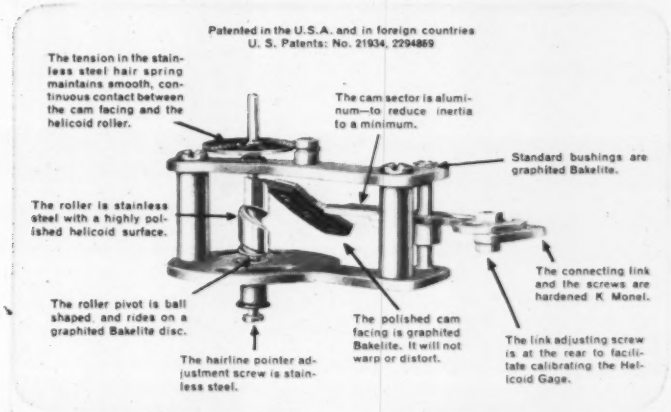
New remote area radiation monitoring system is said to offer "the most reliable and convenient method of continuously monitoring radiation levels"; is based on a modular unit concept so that "customized" installations can be made up from standard units. Elements: basic control unit; plug-in stations mounted singly or in groups of five in control unit; remote sensing units with sealed ionization chamber containing electrometer tube; calibration check source with strontium-90 beta emitter sealed in detector unit; and beta window





Nothing but the best in gages for working pressures from 30" vacuum to 10,000 p.s.i.

These details of Helicoid gage design assure longer life and enduring accuracy


Patented in the U.S.A. and in foreign countries
U. S. Patents: No. 21934, 2294869
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is aluminum—to reduce inertia to a minimum.
Standard bushings are graphited Bakelite.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

The superiority of Helicoid Gages is most evident in severe service—wherever a gage is subjected to violent pressure pulsations or severe mechanical vibrations.

The *sustained accuracy* of Helicoid Gages over *millions of cycles* is explained by the details of design and construction of the Helicoid movement shown above. Such Helicoid features—protect against wear and corrosion and assure sensitivity, sustained accuracy and trouble-free operation.

Easiest adjustment and calibration

Only Helicoid Gages have the external pointer adjustment pictured here. The Helicoid type adjustment cannot be jarred out of position.

Calibration of Helicoid Gages is accomplished easily, without removing dial or pointer, because the link adjusting screw is at the rear of the system.

Tubes built for millions of pressure pulsations

To fit the wide range of applications, Helicoid Bourdon tubes are available in four materials—alloy steel, K Monel, stainless steel and phosphor bronze.

All Helicoid tubes are made from seamless tubing and are carefully designed to give maximum torque and minimum stress. When used within the dial range, they will withstand many millions of pressure pulsations and will not stretch, leak or crack.

For complete information on the Helicoid line of gages write for **Catalog G-52**

Helicoid gives you all these features at prices that are competitive in the quality gage field.

Helicoid Gage Division
AMERICAN CHAIN & CABLE

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ACCO TRADE MARK

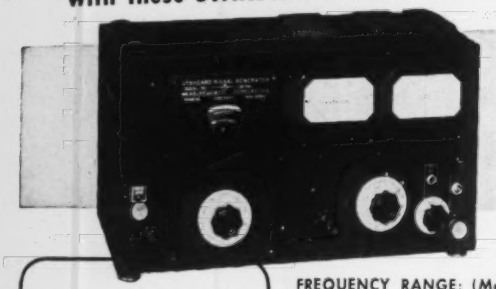
For more information circle **143** on inquiry card.

EXTENDED FREQUENCY RANGE

with these STANDARD SIGNAL GENERATORS

MODEL 80
2 Mc to 400 Mc

MODEL 80-R
5 Mc to 475 Mc



FEATURES

- Direct-Reading scales and dials; individually calibrated.
- Convenient microvolt and DBM output scales.
- Accurate indication of output voltages at all levels.
- Low residual FM due to hum and noise.
- Provision for external pulse modulation.

SPECIFICATIONS

FREQUENCY RANGE: (Model 80) 2 to 400 Mc in 6 bands. (Model 80-R) 5 to 475 Mc in 6 bands.

FREQUENCY ACCURACY: ± 0.5%

FREQUENCY DRIFT: Less than .1% after warm-up.

OUTPUT VOLTAGE: Continuously variable from 0.1 to 100,000 microvolts (−7 to −127 DBM).

OUTPUT ACCURACY: ±10% at 0.1 volt from 5 to 200 Mc. ±15% at 0.1 volt from 200 to 475 Mc.

MODULATION: AM is continuously variable from 0 to 30%. Internal modulation, 400 and 1000 cycles. External modulation, 50 to 10,000 cycles.

RESIDUAL FM: Less than 500 cps at 450 Mc for Model 80-R, and correspondingly lower for both models at lower frequencies.

POWER SUPPLY: 117v, 50-60 cycles, 70 watts.

Laboratory Standards — MEASUREMENTS CORPORATION — BOONTON · NEW JERSEY

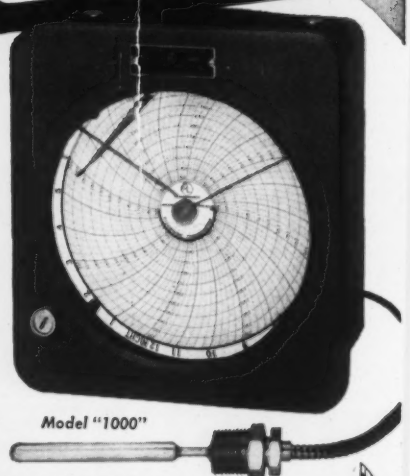
For more information circle **144** on inquiry card.

AUTO-LITE

TEMPERATURE RECORDING...

Newly designed, Model "1000" Auto-Lite Recorder gives permanent proof of temperature behavior. • 6" clear reading chart; various standard ranges from minus 40°F. to plus 550°F. • 3 standard types; choice of 24-hr. or 7-day cycle. • Electric or mechanical chart drive. • With capillary tubing for remote reading. Priced from $49.50.

Send for new catalog describing many styles of Auto-Lite temperature Recorders and Indicators.



Model "1000"

THE ELECTRIC AUTO-LITE COMPANY
INSTRUMENT AND GAUGE DIVISION
TOLEDO 1, OHIO
NEW YORK • CHICAGO • SARNIA, ONTARIO

TEMPERATURE RECORDERS

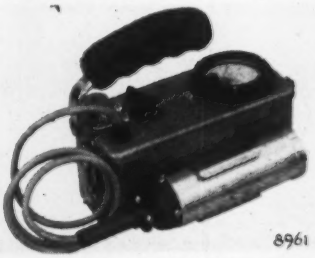
For more information circle **145** on inquiry card.

with discriminator. Control unit can operate up to 20 remote stations. Sensing elements can be located up to 5000 ft. from control point. Output of sensing element being logarithmic, one channel can monitor three decades of radiation intensity on a single scale without switching ranges. Ranges: any three adjacent decades from 0.01 to 1,000,000 mr/hr standard; six decades on special order. Accuracy better than 5% of dose rate when used with built-in calibration check source. Line voltage fluctuations between 100 and 130 cause less than 5% change in accuracy.—*The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.*

For more information circle **414** on inquiry card.

PORTABLE SURVEY METER

New "Model GS-3W," for lab use, employs the same basic circuitry as maker's "GS-3 CD" (first Geiger



8961

counter to meet CD Adm specs); is available as a beta counter with a 3-4 mg/cm² end window, or as an alpha-beta-soft X-ray counter with a 1.4-2 mg/cm² end window. Max counting rate 50,000 cpm or 20 mr/hr.—*Nuclear Measurements Corp., 2460 N. Arlington Ave., Indianapolis 18, Ind.*

For more information circle **415** on inquiry card.

COBALT-60 PILL VAULT

8809

New do-it-yourself storage vault for radioactive cobalt-60 is inexpensive. Two were made by B-L-H's welding shop at a total cost of less than $200. They substitute for equipment which costs as much as $2700. They have been approved by the AEC as safe storage containers for cobalt-60 sources up to 1 curie in strength. Vault consists of a section of 10" steel pipe reinforced at bottom and filled with lead. In center of lead is a small space for ½" x ½" radioactive source. A conical plug covers this space and is fitted with a steel eyelet for easy removal. Design provides a shield of lead 4½" thick on all sides of capsule.—*Baldwin-Lima-Hamilton Corp., Philadelphia 7, Pa.*

For more information circle **416** on inquiry card.

MISCELLANEOUS

WATER QUALITY TESTER

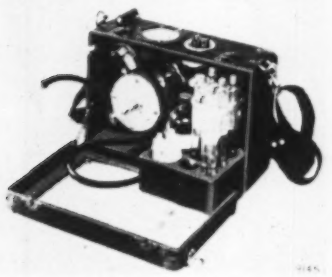
New "Model CT-21 Ionimeter" quickly and economically determines ionic purity of water used in exacting

lab and production applications, features direct-reading dial graduated 0 to 50 in parts per million as NaCl (5,000,000 to 0 ohms); can serve as a companion test unit for maker's new high-capacity water demineralizer, "Deemajet Model DJ-128."—*Crystal Research Labs., Inc., 29 Allyn St., Hartford 4, Conn.*

For more information circle **417** on inquiry card.

VAPOR-DETECTION KIT

New detector kit for TDI (toluene di-isocyanate) and TDI-urea vapors in concentrations of less than 0.1



ppm in air can be operated while being carried; comprises a hand-cranked 4-cyclinder pump with regulator and timer which permit drawing samples of air at 1 l/min for 3 min through glass impinger tube containing 15 ml of dilute aqueous acid solution. Six impinger tubes are included. If air sample contains TDI or TDI-urea, rose pink color appears on addition of three liquid reagents (provided in a replaceable package). Concentrations of 0.05, 0.10, and 0.20 ppm are represented by comparison color standards.—*Mine Safety Appliances Co., Braddock, Thomas & Meade Sts., Pittsburgh 8, Pa.*

For more information circle **418** on inquiry card.

LETTERING TEMPLATE

Newly revised "No. 35" lettering template has latest symbols for draftsmen and engineers; conforms to recent changes in military and industrial standards. It contains a full

OXYGEN

key to modern industrial processes

Control it with...

Arnold O. Beckman INC.

OXYGEN ANALYZERS!

Oxygen is one of the most important factors found in modern chemical and industrial processes. Whether to minimize product oxidation (prepared atmospheres, air infiltration, etc.) ... or to insure adequate oxygen for efficient combustion (boilers, kilns, etc.) ... or to control oxygen for proper process operations (ammonia, acetylene, air fractionation, etc.) oxygen control has become too important in today's operations for any profit-minded executive to overlook.

And because they are the *only* instruments that measure oxygen content directly, accurately and conveniently, Arnold O. Beckman Oxygen Analyzers have become the leading instruments for modern oxygen control in a wide range of applications—from catalytic refineries to cement kilns—from power plants to personnel protection.

These instruments (and systems) can be built to meet *your individual* needs.

These instruments offer many unique advantages...

SELECTIVITY: Highly sensitive to oxygen. Effects of gases other than oxygen are negligible.

HIGH ACCURACY: 1% of full scale (Example: ±0.05% O_2 on range 0-5% O_2).

MANY RANGES: Full scale ranges from 0-1000 ppm or up to 0-100% O_2 available. Combustion ranges 0-5, 0-10, 0-15% O_2 supplied with 0-25% O_2 check range. Multi-range instruments available.

RAPID RESPONSE: Standard Analyzers—95% response in less than 1 minute. Special Units—95% response in 7 seconds!

USE ANY RECORDER: Millivolt output for potentiometers; current output for miniature electronic recorders and galvonometers; air output for pneumatic receivers and control systems.

PACKAGE UNITS: Analyzers and controls may be built into a cubicle with sampling components wired, piped, and ready for installation as a single unit.

SAMPLING SYSTEMS: Complete standard systems—components, package or portable units are available.

OTHER ADVANTAGES: Instruments may be mounted in explosion-proof cases, mounted indoors or outdoors, in portable panels, and have other desired features.

Model F3: Ranges of 0-1%, 0-5%, 0-10%, and higher. Meter on door for convenient readings at sampling point.

Model G2: Full scale ranges 0-0.1%, 0-0.5%, and others for low O_2 content. Ranges 90-100%, 95-100% O_2 for high O_2 content.

The above are but two of the complete line of Arnold O. Beckman Oxygen Analyzers available for every requirement.

Send for helpful free literature which describes Arnold O. Beckman instruments in detail. When writing, outline your particular application—we'll gladly supply specific information.

For General Information Ask for Data File 206-57

Arnold O. Beckman INC.

ANALYZERS

Profit Builders for Industry

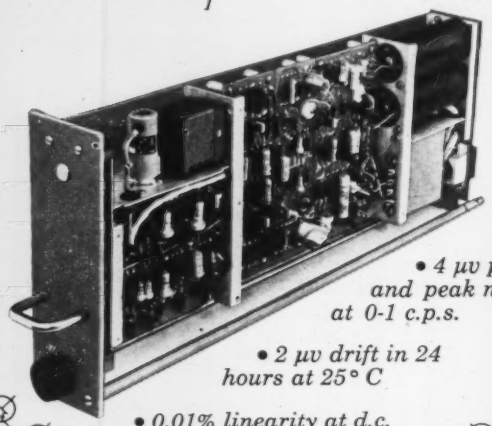
1020 Mission Street

South Pasadena, California

For more information circle **146** on inquiry card.

ALL-TRANSISTOR AMPLIFIER

Beckman / *WN D-C Amplifier*



- *4 μv peak and peak noise at 0-1 c.p.s.*
- *2 μv drift in 24 hours at 25° C*
- *0.01% linearity at d.c.*

The Beckman/WN D-C Amplifier with built-in power supply is completely transistorized . . . for long life and low power consumption . . . for applications requiring the hard-to-find combination of high accuracy and absolute reliability.

A general-purpose chopper-stabilized unit, the Model WN is actually a package of four separate amplifiers, each contributing to the precise amplification of the input signal. Two act as power supplies, producing an accurate plus-or-minus 25-volt potential. The power transformer in these units is completely isolated from ground, so that *the entire amplifier package floats relative to ground.* Elimination of vacuum tubes in all four amplifiers completely frees the Model WN of microphonics, regardless of service conditions. For complete technical details, write for Data File D-11 47.

Beckman® / *Systems Division*

325 N. Muller Ave., Anaheim, Calif.
a division of Beckman Instruments, Inc.

Responsible new positions in engineering, production, technical marketing. Write for Career File 10.

For more information circle **147** on inquiry card.

BALZERS *Thin Film Optics*

From the Principality of Leichtenstein Swiss Customs Area

ROLYN ARCADIA (Calif.)

Front Surface Mirrors, Cold Mirrors, Achromatic Beam Splitters, Dichroic Beam Splitters, Monochromatic Interference Filters, Wedge Interference Filters, Heat-Reflecting Interference Filters, Cut-Off Filters, Anti-Reflection Coatings, Heat Protective Coatings and many other thin layers.

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319 North Santa Anita Ave. • Arcadia, California

ADDRESS REPLY TO P. O. BOX 745 ARCADIA, CALIFORNIA

Balzers means research in high vacuum process

For more information circle **148** on inquiry card.

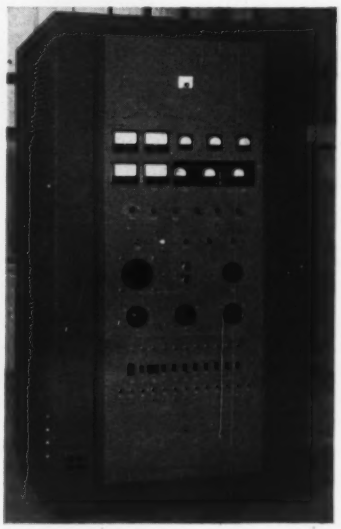
NEW INSTRUMENTS

capital alphabet and numerals with extra symbols for zone blocks, delta and surface roughness symbols, cutting plane arrowhead, and circles with marked quadrants for ⅜", ½" and ⅝" dia. Its corners are rounded to give ¼", ½", ¾" and 1" radius arcs of 90°. Material is 0.065" durable aquamarine plastic.—*E. F. Twomey Co., Inc., 728 W. 10th Place, Los Angeles 15, Calif.*

For more information circle **419** on inquiry card.

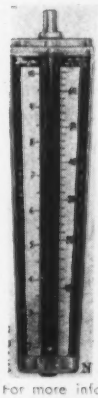
UHF KLYSTRON TRANSMITTER

New "Model PC 57" produces 15 kw peak power.—*Levinthal Elec-*



tronic Products, Inc., 905 Stanford Industrial Park, Palo Alto, Calif.

For more information circle **420** on inquiry card.



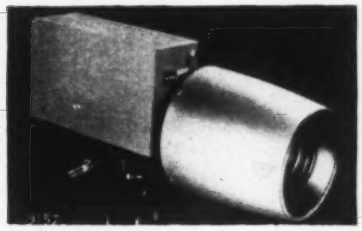
WIND METER FOR BOATMEN

New "Wind Meter," made of tough acrylic plastic, "should last forever." An extremely light-weight molded plastic ball, traveling in a tapered tube, indicates wind pressure directly against a calibrated scale. Covering top orifice with finger switches from "low" scale to high" scale (0-10 and 4-60 mph).—*F. W. Dwyer Mfg. Co., P. O. Box 373, Dept. IAP, Michigan City, Indiana.*

For more information circle **421** on inquiry card.

VARIABLE-FOCAL-LENGTH TV CAMERA LENS

New faster and improved version of "Auto-Zoom" has a speed of *f*/3.5 (more than twice as fast optically as



its *f*/4.7 predecessor) and a 5:1 (30-150mm, 60-300mm) variable focal length range. Improvements in its electrical and control system enable it to be remotely controlled 4,000 feet away from camera (thrice distance possible with original model).—*Perkin-Elmer Corp., Norwalk, Conn.*

For more information circle **422** on inquiry card.

VIDEO MONITORS

New "Model DVM" Deluxe Monitors utilize eleven tubes, plus an aluminized picture tube; are available

in 14", 17" and 21" screen sizes; feature an exclusive dc restorer circuit; have a video response flat within 1 db up to 10 Mc. Input, either composite video or separate sync and video, handles a peak to peak voltage range from 0.25 to 5.0.—*Blonder-Tongue Labs., Inc., 526-536 North Ave., Westfield, N. J.*

For more information circle **423** on inquiry card.

HI-TEMP DIAPHRAGM SEAL

New "Glass" diaphragm seal, by combining a glass fabric with a new silicone rubber, functions in temperature range of −80°F to 500°F, there-

by helps solve some high-speed aircraft problems, especially where pneumatic and fluid systems are concerned. Endurance: one with a cylinder bore dimension of 2", ½" height

QUALITY is not an accident

Product Representatives in Most Principal Cities

It cannot be copied.

It is not attained over night.

Quality is built into E-A Recorders by specialists—workmen whose livelihood depends upon quality and who have spent their lives making just this one product.

For over 50 years, E-A has made the best for those who want only the best in recorders.

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The ESTERLINE-ANGUS Company, Inc.

Pioneers in the Manufacture of Graphic Instruments

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For more information circle **149** on inquiry card.

DON'T DROP THAT SCREW!

Hold it with an H.J.J. Screw-holding Driver

Sizes to handle from #0 to #¼" screws

The H.J.J. COMPANY

268 Marlow Drive • Oakland 5, California

For more information circle **150** on inquiry card.

HASLER SPEED INDICATOR

Chronometric Tachometer with separate reset button for cumulative readings

Accurate
Automatic
Durable
Flexible
Portable
Non-magnetic

Type A	0-20,000 r.p.m. or 0- 6,000 f.p.m.	Size 2¾" x ⅞" x 4"
Type B	0- 2,000 r.p.m. or 0- 600 f.p.m.	Spindle incl. Weight 7¾ oz. ready for test

Shipment within 5 days from stock

Sales and Service by

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U.S. Distributors for Hasler Speed Indicators since 1919

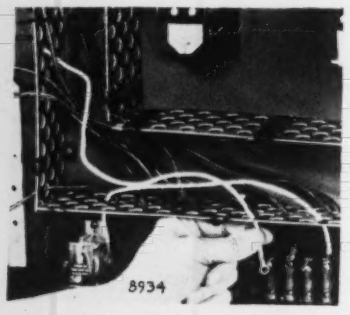
For more information circle **151** on inquiry card.

and ⅛" stroke, at 50 psi delivered 250,000 cycles at 500° F, whereas present military requirements call for 10,000 to 50,000 cycles for diaphragms of this sort.—*Bellofram Corp., Burlington, Mass.*

For more information circle **424** on inquiry card.

WIRING DUCT

New 2" high size of "Channel-Duct," for simplifying panel wiring, is added to 3" size; extends only 2"

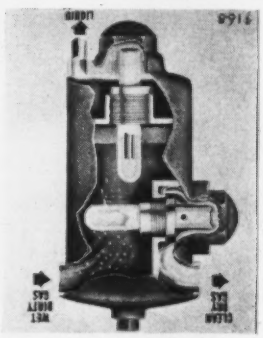


away from panel. It cuts fabrication and assembly costs in production of control panels: wires are laid in the glass-reinforced polyester duct, then strung through holes to nearest connection points before cover strip is snapped on.—*The Glastic Corp.*, 4321 *Glenridge Road, Cleveland* 21, *Ohio.*

For more information circle **425** on inquiry card.

LIQUID-GAS SEPARATOR

New "Liqui-Jector," for removal of entrained liquids and solids from air, gas and steam systems, is available in 12 standard sizes. (Previously, units were specially designed and custom-built). It provides clean dry air for operating pneumatic equipment and control instruments and systems.



It operates by phase separation; trapping solids, and passing liquid in one direction and gas in another, without interrupting flow through line. Three standard models: "Series A" for volumes up to 100 scfm gas at 150 psig; "Series B" 7,000 scfm gas at 200 psig; and "Series C" unusually large volumes of condensate. Note: maker continues to build specially-engineered units.—*Selas Corp. of America, Dresher, Pa.*

For more information circle **426** on inquiry card.

SHIPPING CONTAINERS

Newly expanded line of "Reusable Shipping Drums" comprises eight sizes with capacities from 88 to 221

cubic inches, all specifically designed for shipping instruments, timepieces and fragile equipment; also designed for easy stacking. Among features: watertight when assembled, one-piece body, baked finish, compliance with MIL specs.—*Sheet Metal Specialty Div., Follansbee Steel Corp., Follansbee, W. Va.*

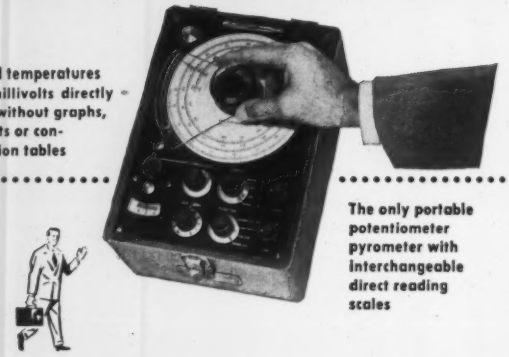
For more information circle **427** on inquiry card.

ROOM THERMOSTATS

New room thermostats incorporate a new variable heat anticipator which helps provide even temperature control under extreme weather conditions. This anticipator causes thermo-

Check and calibrate any type of thermocouple-actuated temperature instrument with one portable Pyrotest

Read temperatures or millivolts directly . . . without graphs, charts or conversion tables



The only portable potentiometer pyrometer with interchangeable direct reading scales

Pyrotest is 9 instruments in one, with 6 standard scales for thermocouples; 3 standard scales for millivolt readings. Special scales for any desired reading or use. Scales interchangeable in 30 seconds. Compact, rugged, easy to carry—12 lbs.; 12" x 9" x 8½". Accurate to 1/6 of 1%. Self-contained power supply. Write for new bulletin 9B.

TECHNIQUE

TECHNIQUE ASSOCIATES
211 E. SOUTH STREET
INDIANAPOLIS 25, IND.

For more information circle **152** on inquiry card.

A NEW DIMENSION IN DESIGN MATERIAL...

PRECISION BORE GLASS TUBING

Wilmad Offers Unheard-Of Accuracy and Low Cost

Design Engineers are constantly searching for new materials to reduce costs and improve preformance. Wilmad has helped make glass a "new" material by producing precision bore tubing of uniform accuracy with amazing tolerance limits. Wilmad Precision Bore Tubing can be used in making product components, instrument assemblies or sub-assemblies, wave guide tubes, manometers, rotameters, viscosimeters, barometers, McLeod gauges, dilatometers, burettes, dash pots, capacitors, diodes . . in virtually hundreds of precision applications in industry.

Learn how precision bore glass tubing can improve **your** product. Let our engineers help you determine how Wilmad Glass Tubing can solve your design problems.

Write for our **new** bulletin on Precision Bore Tubing.

WILMAD GLASS CO., INC.
Landisville, New Jersey

For more information circle **153** on inquiry card.

HEAVY DUTY D. C. SOLENOIDS

MODEL SS

VOLTAGES . . . . (D.C. Only) 6V. 12V. 24V. 32V.

CURRENT DRAW . . (Pulling) 50A. 30A. 17A. 7.5A.

CURRENT DRAW . (Holding) 1.7A. .95A. .28A. .25A.

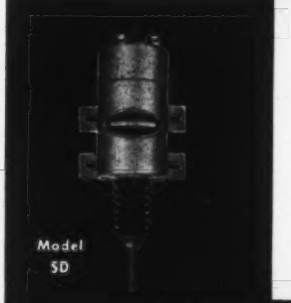
DUTY . . . . . Continuous

CYCLES . . Not to exceed 6 per minute

PULL . . Approximately 10 lbs. over ½" stroke

WEIGHT . . . . . 2¼ lbs.

Model SS



Model SD

MODEL SD

VOLTAGES . . . . (D.C. Only) 12V. 24V. 32V. 115V.

CURRENT DRAW . . (Pulling) 31A. 26A. 16A. 3.6A.

CURRENT DRAW . (Holding) .60A. .31A. .19A. .07A.

DUTY . . . . . Continuous

CYCLES . . Not to exceed 6 per minute

PULL . . Approximately 10 lbs. over 1½" stroke

WEIGHT . . . . . 4 pounds

SYNCHRO-START PRODUCTS, INC.

8151 N. RIDGEWAY AVE., SKOKIE, ILLINOIS

For more information circle **154** on inquiry card.

GET *automatic* LIQUID DENSITY CONTROL WITH THE PRINCO DENSITROL

APPLICATIONS

CHEMICAL
PETROLEUM
PAPER
TEXTILE
SUGAR
JET FUEL

DENSITROL

The DENSITROL is an extremely accurate, sensitive instrument for continuously, accurately and automatically controlling or recording the blending, mixing, separation, dilution or concentration of industrial process liquids. It quickly pays for itself because it eliminates operator attendance and does on a continuous basis what formerly was done on a batch basis.

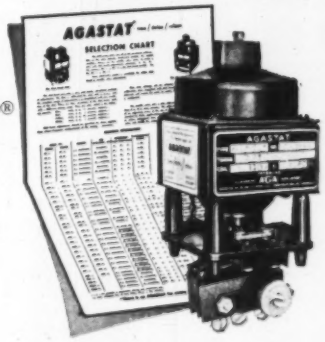
For ranges, calibrations and other specifications, write, wire or call.

PRECISION THERMOMETER & INSTRUMENT CO.

1434 BRANDYWINE STREET • DEPT. CP. • PHILA. 30, PA. • RI 6-6671

For more information circle **155** on inquiry card.

FREE SELECTION CHART for AGASTAT® time delay relays



Now you can select exactly the right Agastat time delay relay for your particular timing need—in a hurry. This free selection chart lists data on every popular model in the Agastat line—the most complete line of pneumatic time delay relays in the industry. They're adjustable for timing from 0.1 second to 10 or more minutes, unaffected by voltage variation, dustproof, light, and mountable in any position. And there's an Agastat model to precisely fit your requirements, including two-step, electrical interlock and double head units. A glance at the free selection chart tells you which model to order.

Write for your free copy to Dept. A26-59

AGA DIVISION

Elastic Stop Nut Corporation of America

1027 Newark Avenue, Elizabeth, New Jersey

Pioneers in pneumatic timing.

For more information circle **156** on inquiry card.

NEW **SCHAEVITZ LVDT**

combines higher sensitivity with operation over wide temperature ranges

◀ ACTUAL SIZE

PRINCIPAL FEATURES:

LINEAR RANGE: ±0.060 inch (total linear travel, 0.120 inch)

AMBIENT TEMPERATURE RANGE: −65° to + 450°F

SENSITIVITY: 0.5 megohm load

at 60 cps 2 millivolts/0.001"/volt in
400 cps 6 millivolts/0.001"/volt in
2000 cps 6 millivolts/0.001"/volt in
10000 cps 7 millivolts/0.001"/volt in

The new magnetically shielded SCHAEVITZ Type 060XS-ET Linear Variable Differential Transformer offers increased output sensitivity in addition to the usual LVDT features, including a highly linear response to core displacement. The 060XS-ET is supplied for any frequency from 50 to 20,000 cps. When operated at 2000 cps, sensitivity is particularly stable with changing temperature, and carrier phase shift is approximately zero. LVDT resolution is essentially unlimited.

Write, wire or call us for other significant details.

schaevitz engineering

P. O. Box 505 Camden 1, N. J. MErchantville 8-5353

For more information circle **157** on inquiry card.

PLASTIC LENSES FOR AUTOMATION

. . . because they are **UNBREAKABLE,** lightweight, **VERSATILE, LOW COST** and easily machinable

SPHERICAL and PRISMATIC SHAPES • FRESNEL LENSES and LENTICULAR SCREENS • OPTICAL SPECIALITIES

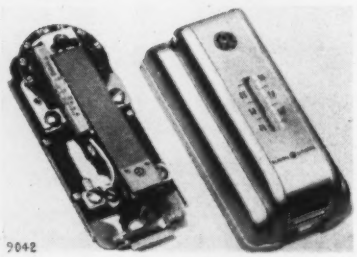
OPTICS lenses, precision-processed or molded, are ideal aids to instrumentation for purposes of magnification, reduction, image displacement, and a host of adaptations.

For complete information, WRITE:

OPTICS MANUFACTURING CORP.
Amber & Willard Streets Phila. 34, Pa.

For more information circle **204** on inquiry card.

NEW INSTRUMENTS



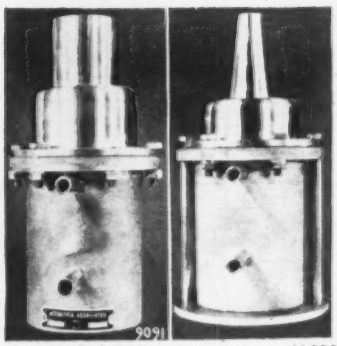
9042

stat to turn heating system off before room temperature is too high and to turn it back on before temperature dips too low. It obviates need of matching pre-heat resistor with control circuit: one thermostat can be used with all 24-v gas and oil control circuits from 0.2 amp to 0.8 amp. A built-in slider on anticipator is set at time of installation for particular heating system control circuit. Moreover, it can be set with vernier accuracy to provide an exact cycle time.—*Appliance Control Dept., General Electric Co., Schenectady, N. Y.*

For more information circle **428** on inquiry card.

ULTRASONIC TRANSDUCERS

Two new additions to maker's line of ultrasonic "building block" transducers are designed for use in high-temperatures environment and for developing high-amplitude ultrasonic motion; feature internally biassed



9091

water-cooled 400-watt average (1600-w peak) magnetostrictive driving elements operating at 25 kc; can be driven singly or in groups by appropriately rated standard ultrasonic generators from 400 w to 10 kw and above. "Model AT-1600B," left, features water-jacket coupling slug permitting use of high-power magnetostriction transducers for temperatures up to 1500°F. "Model AT-1600C," right, features a tapered steel amplitude multiplier, advantageous when large peak-to-peak amplitudes are required.—*Acoustica Associates, Inc., Glenwood Landing, Long Island, N. Y.*

For more information circle **429** on inquiry card.

CORRECTION

Item on MINIATURE DC MOTOR of Minitone, Inc. (March issue, page 534) should end: " . . . guaranteed life in excess of 1000 hours."

Chip-proof PLASTIC LEGEND PLATES

engraved in your own plant

Tough **GRAVOFLEX** blanks are laminated in sharp contrast colors. No need to keep large inventory—all sizes, varied colors available on short notice. Low-cost GRAVOFLEX legend plates stand *up* better, stand *out* better!

Use the portable **ENGRAVOGRAPH** to mark legend plates to your specifications, on the spot, when you need them—with unskilled labor, because it's tracer-guided. Big savings on short runs and "one-shot" jobs. Eliminates costly delays. Over 17,000 in use.

Send for Booklet XL-1 and sample plate.

neu hermes ENGRAVING MACHINE CORP.
13-19 UNIVERSITY PLACE, NEW YORK 3, N. Y.

SHOWS CO Hazard *INSTANTLY*

MONOXOR CARBON MONOXIDE DETECTOR

- Shows CO hazard directly — at a glance
- Requires no color matching or reference to comparator scales
- Test takes only a few seconds
- Simple in operation; easy to use
- No special training needed

REPLACEABLE DETECTOR TUBE CONTAINS YELLOW CHEMICAL WHICH TURNS BROWN WHEN AIR "SNIFFED" THROUGH DETECTOR TUBE BY PENCIL-SIZE ASPIRATOR CONTAINS CARBON MONOXIDE

$22.70
Price Complete—includes MONOXOR Instrument, 24 Detector Tubes, 6 Tube Caps, in Pocket Case

The MONOXOR detects presence of CO, even in concentrations as low as 100 parts CO per million parts of air. Particularly useful for a spot-check of carbon monoxide contamination in garages, vehicular tunnels, mines, industrial plants and wherever gas appliances are operated.

For Complete Particulars . . . Clip this ad and mail to us with your name and address, or write for Leaflet 859.

BACHARACH INDUSTRIAL INSTRUMENT CO.
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Telephone: CHurchill 2-5400 M-9r

For more information circle **158** on inquiry card.

SERVONIC

DO YOU NEED THE ADVANTAGES OF A POTENTIOMETER TYPE TRANSDUCER?

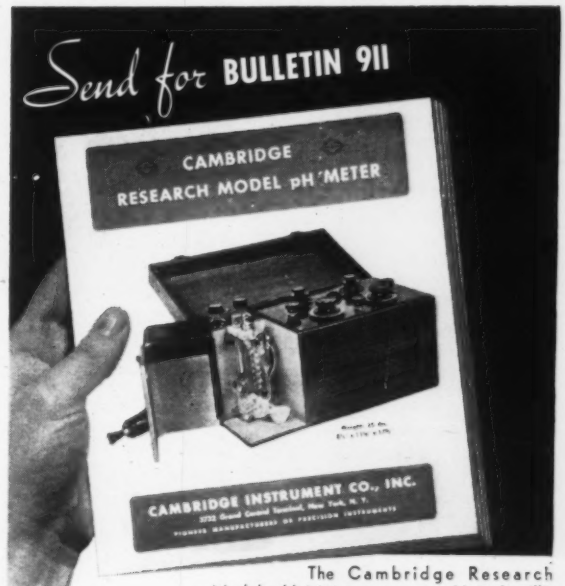
Servonic "Model H" pressure transducers retain system simplicity and high electrical output, but they offer these operational extras . . .

RUGGED	Vibration resistant — plus or minus 20 g's. — 100 to 2000 cps.
STAINLESS STEEL	Corrosion resistant — two corrosive fluids. — gauge and differential models.
LONG LIFE	Lubricated bearings and potentiometer. Sealed against the action of dust and humidity.
UNIQUE CONFIGURATION	Designed for "Stacking." Designed for easy access to electrical and fluid connectors.
OPERATIONAL RANGES	Temperature — minus 65°F. to plus 400°F. Pressure — 1000 to 10,000 psig. — 1000 to 10,000 psid.

SERVONIC INSTRUMENTS, INC. | 1145 So. Fair Oaks Pasadena 2, Cal. • RYan 1-1187

For more information circle **159** on inquiry card.

Send for BULLETIN 911



The Cambridge Research Model pH Meter measures pH and millivolt values where extreme precision and reliability are required. Although originally designed for biological and physiological use, the instrument is particularly useful in the Chemical, Pharmaceutical and Process Industries. The combination of features is not to be found in any other similar instrument.

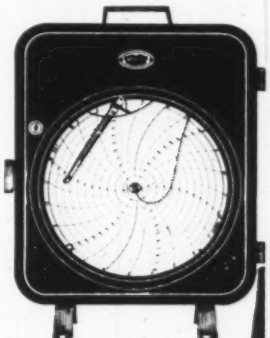
CAMBRIDGE INSTRUMENT CO., INC.
3526 Grand Central Terminal, New York 17, N. Y.

PIONEER MANUFACTURERS OF PRECISION INSTRUMENTS

For more information circle **160** on inquiry card.

Get these 4 extras in WEKSLER RECORDING INSTRUMENTS

- SUPERIOR DESIGN
- GREATER ACCURACY
- EXTRA LONGEVITY
- MAXIMUM SAFETY



Weksler Recording Instruments for Temperature and Pressure are designed to meet the needs of every industry.

For further information on Weksler Recording Temperature or Pressure Recorders send for Bulletin R57.

WEKSLER INSTRUMENTS

WEKSLER THERMOMETER CORP.
195 E. MERRICK ROAD, FREEPORT, L. I., N. Y.

For more information circle **161** on inquiry card.

280 SERIES METERING VALVES for

precise control

20 TURNS moves the stem only 3/8"

For precision flow control use this brass bar stock metering valve, equipped with an O-ring stem seal. The extra long, sharp, needle point stem (8° included angle) and fine spindle threads insure accurate control for pneumatic or hydraulic service, or precision laboratory work. In 1/8" and 1/4" pipe sizes. Your choice of 1/16" or 1/8" orifices. Available for Panel Mounting, too.

For complete information send for Bulletin No. BSV 256.

HOKE

HOKE INCORPORATED
Fluid Control Specialists
231 S. DEAN STREET, ENGLEWOOD, N. J.

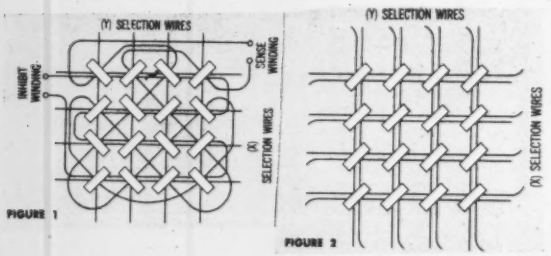
For more information circle **162** on inquiry card.

For this literature circle number on inquiry card.

Memory Planes

General Ceramics random-access, coincident-current magnetic memories offer application-proven dependability. Practically all computers employing this type system incorporate General Ceramics Ferramic cores. These ferrite ceramic cores provide highly rectangular hysteresis loops for adequate retention of information and proper selectivity. Applications include automatic controls for conveyors, elevators, traffic, production machines, signalling, processing equipment and other systems.

Type 1: For use in standard coincident-current random-access-type memories. Each core has one X-winding, one Y-winding at 90° for the X winding. A Z or inhibit-winding parallels the X winding with a sense-winding diagonally across the memory frame. Sense and Inhibit windings are split into two sections. Sense winding is threaded through the cores in a way that reduces noise pickup. The output of the sense winding may be either positive or negative, depending on the core selected. Type 1 memory frames available in four standard sizes: 10 x 10, 16 x 16, 32 x 32 and 64 x 64 frame.



Type 2: This type memory plane has two windings in the X direction and two windings in the Y direction. Thus there are four isolated single turn windings. (*From new* 4-*page Bulletin MP*-105, *General Ceramics Corp., Keasbey, N. J.*)

For this literature circle **501** on inquiry card.

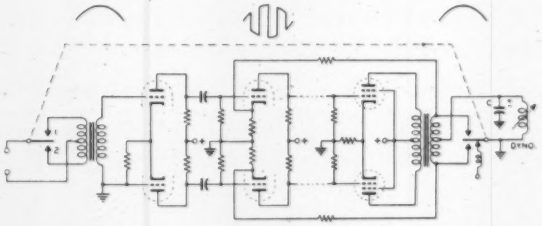
Why a Chopper?

The chopper amplifier is an integral part of the Dynograph Direct-Writing Oscillograph. The "why" of the chopper amplifier is an interesting example of many benefits deriving from one design feature.

The basic principle of the amplifier is shown in Fig. 1. The input voltage, be it d-c or a-c, is converted into a so-called square wave. This is amplified, and finally re-synthesized by output contacts on the same chopper to the original wave-form.

The first and most obvious advantage of the chopper amplifier is its complete freedom from drift. While all other types of d-c amplification depend on the balance of currents, voltage, position, etc., and therefore may have drift, in a chopper amplifier no such drift is possible: a change in output occurs only with changing input. This permits the construction of a completely stable d-c amplifier of unusual sensitivity: 15 micro-volts per millimeter of pen deflection.

But the chopper amplifier has other advantages. An input transformer can be employed, with the input chopper ahead of it, producing in effect a "d-c transformer." The complete electrical isolation of input from ground gives a practically perfect differential input. This is



especially useful in bridge measurements, but also permits the input source to be at a relatively large potential difference from ground: up to 500 volts.

An output transformer is also employed. This permits matching the high output load impedance of a vacuum tube amplifier to a low resistance load.

The use of the output transformer at the same time makes possible the efficient coupling of the power amplifier to the Dynograph coil . . . and a high torque movement with inherently high response speed. The result is large pen excursion (over eight centimeters), no hysteresis (the pen always returns to precisely the same base line), and a frequency response which is accurate at low amplitudes as well as high. (*From new* 2-*page Data Sheet and* 12-*page Bulletin L*-861, *Offner Electronics Inc.*, 5320 *N. Kedzie Ave., Chicago* 25, *Ill.*)

For this literature circle **502** on inquiry card.

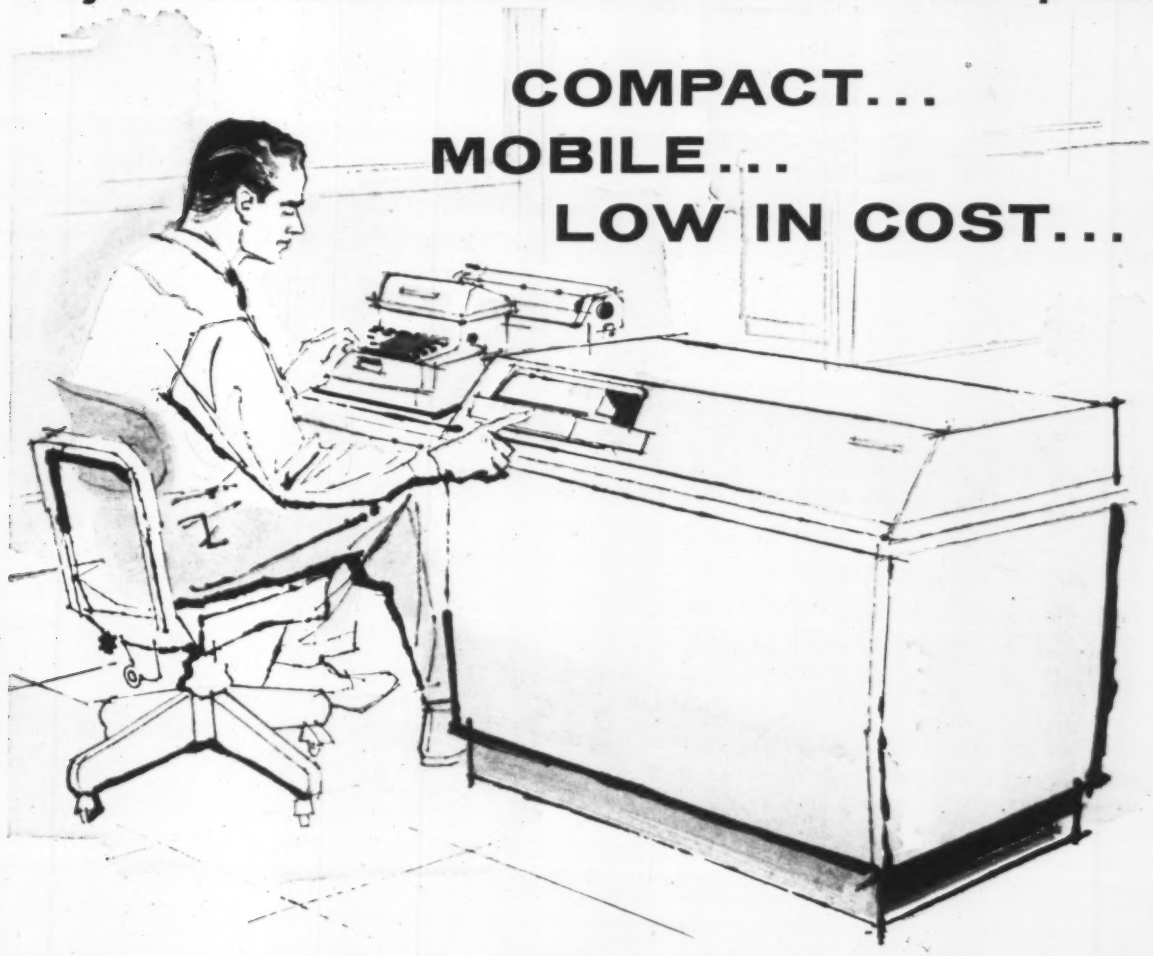
Plug-In Diode Logics

The table on this page includes a representative list of logic equations obtainable from EECO diode logic circuits. Although a wide range of equations is covered, it is only natural that individual problems will dictate the need for equations other than those listed . . . (*From new* 76-*page Catalog* 856-*A*, *Engineered Electronics Co.*, 506 *East First St., Santa Ana, Calif.*)

DIODE LOGIC CATALOG NO.	"AND" CIRCUITS	"OR" CIRCUITS	LOGIC EQUATIONS
Y-423	4	1	P = AB + FH + NJ + MR
Y-424	3	1	P = AB + EF + MN + R
Y-425	3	1	N = ABD, E = FHJ + KMR + P
Y-426	0	2	N = A + B + E, M = F + H + J + K
Y-427	4	0	A = BED, J = BDH, N = BEM, R = PFK

For this literature circle **503** on inquiry card.

Royal Precision LGP-30 Electronic Computer



high-speed computation right at your desk

The result of 20 years' experience in the design of electronic computers, LGP-30 puts you in complete control of your own engineering problems. Used right at your desk, LGP-30 allows you to program your own material without planning in detail. You modify equations on the spot, follow your work to completion. Thus, you eliminate much detailed calculation . . . uncover added time for creative engineering.

Ease of operation. LGP-30's simple command structure offers the same complete internal programming found in computers many times its size and cost. Internally binary, serial, single address . . . LGP-30 enters and reports alpha-numeric information by punched paper tape or keyboard.

Greatest capacity in price range. The most powerful stored program computer of its size yet developed, LGP-30 has a magnetic drum "memory" of 4096 words. Fully automatic, it performs sub-routines . . . executes self-modifying programs.

Exceptional flexibility. LGP-30's wide range of applications includes double precision abstractions; compiling and diagnostic routines; 3-address interpretive routine with floating point abstractions; matrix operations including inverting and Eigen value problems; basic trigonometry and log functions; square root and roots of polynomials.

Nation-wide sales and service. Detailed analysis of your requirements is available through Royal McBee's nation-wide staff of trained applications engineers.

Outstanding features of LGP-30

- Operates from regular wall outlet (110 volts AC).
- No expensive installation . . . no external air conditioning.
- Unusually large "memory"— 4096 words.
- Word length: 32 bits, including sign and spacer bit.
- Average access time: 8.5 ms.
- Optimum access time: 2 ms.
- Lowest cost ever for a "complete" computer.
- Nation-wide sales and service.

For further information, write Royal McBee Corporation, Data Processing Equipment Division, Port Chester, N. Y.

ROYAL McBEE
CORPORATION
ROYAL TYPEWRITERS • McBEE BUSINESS SYSTEMS

For more information circle **163** on inquiry card.

For more information circle **164** on inquiry card.

BRIEFS—CONTINUED

Rhodium

Rhodium is one of the six Platinum group metals all of which are inert, stable, tarnish resistant, corrosion resistant and generally white in color. It has been known to science since 1803 when it was discovered by Wollaston.

Because of its whiteness, hardness, high reflectivity and corrosion resistance Rhodium makes an ideal electoplate for many applications . . . Rhodium electroplated electrical contacts exhibit exceptionally low contact resistance and are desirable for delicate contacts involving small current and very low voltage.

The only metals usually used for reflecting surfaces which have a reflectivity higher than that of Rhodium are freshly polished silver and aluminum, which however lose their high reflectivity after exposure to the atmosphere.

Approximate Reflectivity at 550 Mu

Silver (Freshly Polished)	94%*
Rhodium	76%*
Iridium	70%
Aluminum	90%
Nickle	67%*
Chromium	67%*
Platinum	65%
Palladium	63%

***Determined by the National Bureau of Standards**

Rhodium is very much harder than any of the other metals shown above with the exception of chromium, the reflectivity of which is much lower than that of Rhodium. This makes Rodium very desirable for a reflecting surface since it combines hardness with high reflectivity and can be frequently cleaned by wiping, if necessary, without danger of scratching.—(*From 4-page Brochure "The General Properties of Rodium," Sigmund Cohn Mfg. Co., Inc., 121 So. Columbus Ave., Mount Vernon, N. Y.*)

For this literature circle **504** on inquiry card.

Who likes to keep a customer waiting? Not the men of Plummer & Kershaw at any rate. Unfortunately scheduling is easy but producing to the high quality standards that have made P & K respected, is another thing. Work done with skill and care is not work that can be produced quickly. As inevitable then as night follows day it is necessary to specify longer delivery dates—we feel sure you wouldn't want it otherwise.

TURN TO PLUMMER AND KERSHAW FOR—

- Complete Optical Instruments made to Specifications.
- Design and Manufacture of Optical Systems using Glass, Crystal or other Transmission Media.
- Lenses and Prisms of Many Types
- Test Glasses.

PLUMMER and KERSHAW

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For more information circle **165** on inquiry card.

The New SCHERR
MICRO-PROJECTOR
with the
VERTICAL design

NEW
1957
SELF CONTAINED
IMPROVED MODEL

FEATURING

- ✓RIGID FLOOR BASE - ELIMINATING EXTRA CHARGE FOR TABLE
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- ✓4" DIA. STAGE OPENING
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- ✓AN ENTIRELY NEW PRACTICAL DESIGNED TOOL FOR INSPECTION DEPARTMENT AND PRODUCTION SHOP.

WRITE FOR ILLUSTRATED FOLDER

GEO. SCHERR CO., Inc.

COMPLETE LINE OF PRECISION INSTRUMENTS

200-MG LAFAYETTE STREET • NEW YORK 12, N.Y.

For more information circle **166** on inquiry card.

Magnetic Amplifier for Hydraulic Valve

High gain and fast response is achieved in the single stage unit by operating at a supply frequency of 5,000 or 3600 cps . . . . The amplifier is suitable for controlling low-power-output devices such as hydraulic servo valves. The amplifier characteristics are such that a complete high performance electro-hydraulic servo loop can be achieved without the use of additional amplifying elements . . . . A static converter from 400 cps to 5000 cps or 3600 cps is available. (*From new 1-page Leaflet S765, Magnetic Amplifiers, Inc., 632 Tinton Ave., New York 55, N. Y.*

MODEL	MA-500130-DW	MA-360130-DW
Power Supply	60V CT at 5,000 cps	60V CT at 3,600 cps
Maximum Power Output	.2 watts D.C.	
Rated Output Voltage	15V D.C. differential	
Rated Output Current	15 m.a. D.C. differential	
Typical Load	2-1000 ohm coils	
Maximum Power Gain	10^5	
Input Resistance (2 control windings series connected)	3000 ohms	
Sensitivity (2 control windings series connected)	25 microamperes for rated output	
Time Constant	Approx. .004 sec. with 50K ohms forcing resistor—one control winding only (5000 cps)	

For this literature circle **505** on inquiry card.

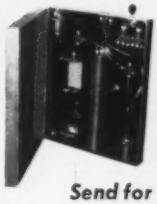
Measure Specific Gravity Accurately!

. . . and from a remote point

The Petrometer remote reading Specific Gravity Indicator is accurate to .001 Sp. G. unit, with interpolation to .0005 unit! It's easy to install . . . and operates on the simple, sound principle of a differential bubbler.

An ideal instrument for plant or laboratory for measuring specific gravity of any liquid . . . paints, fuel, resins, pharmaceuticals, chemical solutions.

All functional parts are conveniently mounted on rear of panel, accessible by swinging open the cabinet door.



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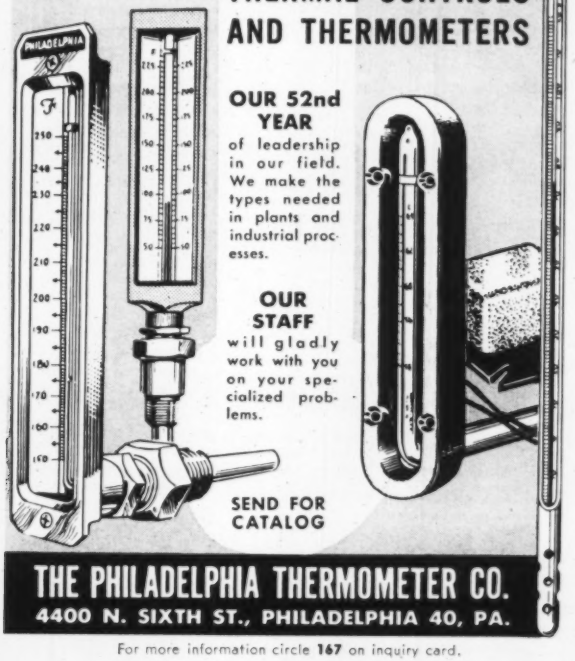

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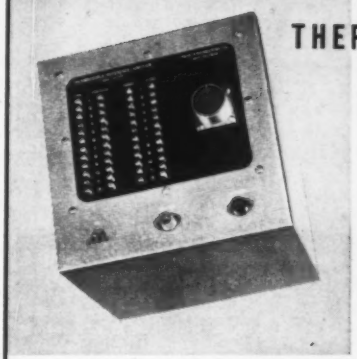
PACE

THERMOCOUPLE REFERENCE JUNCTION



RJ SERIES THERMOCOUPLE REFERENCE JUNCTIONS operate from 115 volt line to provide thermostatically controlled temperature reference for multi-channel thermocouple systems. Reference Junction permits use of copper lead wire without inconvenience of ice-bath maintenance, and eliminates necessity for cold-junction compensation.

Features . . .

Temperature stability within ½°F, and uniformity within 0.1°F.
Control temperature adjustable.
Multi-wire junctions available for thermocouple choice in each channel.
Variety of thermocouple types, number of channels and input-output connections offered in standard models.

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For more information circle **170** on inquiry card.

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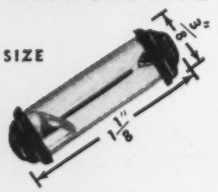
MERCURY SWITCH

MINIATURE TYPE

ACTUAL SIZE



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Introducing a new Mercoid hermetically sealed mercury switch—a tilting type switch designed to be installed in the same manner as a cartridge fuse (spring clips or holders can also be used for mounting purposes).

Operation is noiseless and contact position is readily visible.

Its small size and light weight make it particularly adaptable for such applications as business machines, coin operated machines, signals, sign flashers or refrigerator doors.

Electrical rating: SP-ST: 1.75 amp. 115 volts; 0.6 amp. 230 volts.

WRITE FOR BULLETIN 665

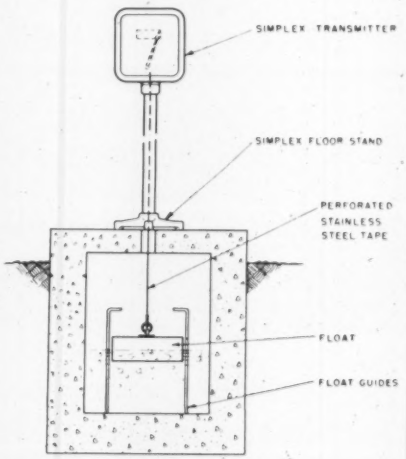
THE MERCOID CORPORATION
4209 Belmont Ave., Chicago 41, Ill.

For more information circle **171** on inquiry card.

BRIEFS—CONTINUED

Simplex Orthoflow System

The basic Orthoflow system or the Simplex Type "900", consists of the transmitter and receiver linked together



by a two-wire circuit which has power applied at both ends . . .

When transmission of multiple intelligences is required each standard transmitter is so wired that it keys an associated terminal tone generator, thus transmitting a different audio-frequency signal for each transmitter. (*From new 40-page Catalog 005, Simplex Valve & Meter Co. Lancaster, Pa.*)

For this literature circle **506** on inquiry card.

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The gauge that has everything!

- **LEAK-PROOF ONE-PIECE CONSTRUCTION** . . . bourdon tube fused to socket and tip by exclusive "Conoweld" process.
- **STURDY "MARSHALLOY" CASE** . . . formed of boiler-plate-thickness steel, copper clad inside and outside to give it the corrosion resistance of solid copper. It's one third lighter, but four times stronger than cast iron.
- **PRECISION "MASTERGAUGE" MOVEMENT** . . . with such exclusive features as the coined sector gear.
- **AVAILABLE WITH STAINLESS TUBE AND SOCKET** . . . choice of stainless steels and alloys for all corrosive conditions.
- **WITH "RECALIBRATOR"** . . . quickest and best way to keep a gauge accurate.

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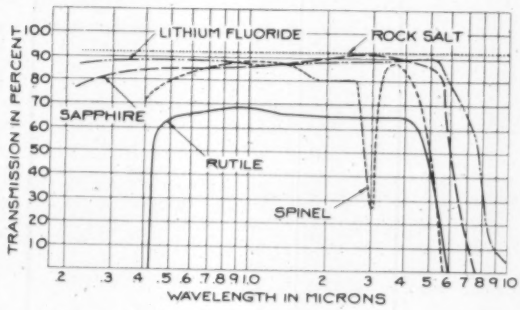
Houston Branch Plant: 1121 Rothwell St., Sect. 15, Houston, Texas.

For more information circle **172** on inquiry card.

Synthetic Sapphire

In recent years the production of synthetic sapphire has made available a material that, in 2-mm thick sections, transmits radiation over the wavelength range from 0.17 to 6.0 microns . . . and is physically strong and chemically inert. While strain and optical anisotrophy somewhat limit the use of sapphire as a precision lens element, sapphire will be of considerable interest in optical systems where its wide transmission band, its high temperature



properties and its abrasion resistance become dominating considerations . . .

Sapphire is an anisotropic crystal and its properties vary with the direction of measurement. It is convenient in discussing the crystal properties to use the hexogonal set of axes C, A_1 and A_2. For example, the two indices of refraction, one with the vibration direction parallel to the C axis (the extraordinary ray N_e) and the one with the direction of vibration perpendicular to the C axis (the ordinary ray N_o) completely specify all indices of refraction for the crystal. (*From 20-page Paper F-8727 by Dr. Richard W. Kebler, Linde Air Products Co., 30 E. 42nd St., New York 17, N. Y.*)

For this literature circle **507** on inquiry card.

Rotary Type
HIGH VACUUM PUMP

Model 53BF

Down to 2mm Absolute Pressure

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- Positive Vacuum without pulsation.
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- Improved Noise Protection.
- Occupies less space than any other pump with same pumping capacity.
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Range of ratios from 2 to 1 to infinity!

Accessibility on three sides permitting panels up to 30" diameter to be engraved, milled or profiled. Vertical range over 10" allowing operations on complete chassis, cabinets or other bulky objects.

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A brochure with full details is yours upon request.

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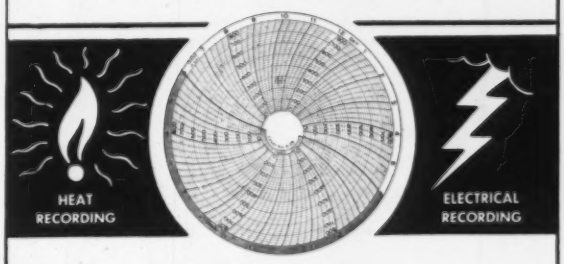

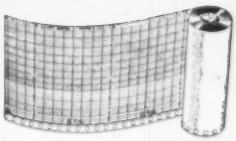

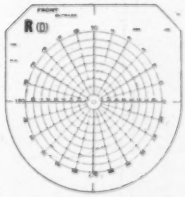

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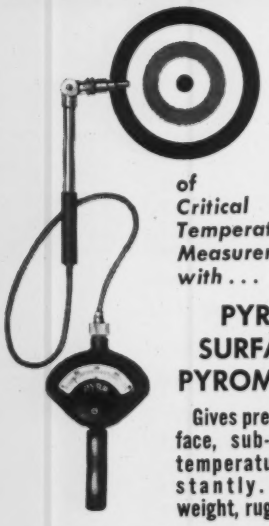

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INSTRUMENTS and AUTOMATION

New Literature

MOTORS, SERVOS

HERMETIC MOTORS. New 10-page Bulletin GED-3060 describes how high-speed production facilities, quality control, and research are used in manufacturing hermetic motors for the refrigeration and air conditioning industry.—General Electric, Holland, Mich.

Circle **508** on inquiry card.

MOTORS. New 16-page issue of "This Month," (March and April, 1957) features motor and electronic components available from company.—Herbach & Rademan, Inc., 1204 Arch Street, Phila. 7, Pa.

Circle **509** on inquiry card.

TEMPERATURE

TEMPERATURE CONTROLS. New 8-page booklet, F 8031, discusses functions, uses and advantages of maker's "Electronic" control centers with visual supervision of entire heating or air conditioning system.—Barber-Colman Co., Rock St., Rockford, Ill.

Circle **510** on inquiry card.

OVENS. New 4-page Bulletin 5520-A describes "Blue M" electric ovens, furnaces and related equipment for research, pilot plant, and production.—Boder Scientific Co., 810-814 Penn Ave., Pittsburgh 22, Pa.

Circle **511** on inquiry card.

THERMOSTATS. New 2-page Bulletin 3000 describes maker's new line of bimetal semi-enclosed, and hermetically sealed disc type thermostats.—Stevens Mfg. Co., Inc., Lexington, Ohio.

Circle **512** on inquiry card.

TEST CHAMBERS. New 2-page Bulletin D-1208 provides information on maker's Model TC-4; and new 6-page Bulletin D-1191 describes Model TC-2A temperature test chambers.—Statham Development Corp., 12411 West Olympic Blvd., Los Angeles 64, Calif.

Circle **513** on inquiry card.

HEATERS. New 20-page Bulletin SA-571 presents data on gas unit heating and gives basic information on the selection and installation of equipment.—Reznor Mfg. Co., Mercer, Pa.

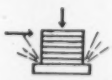
Circle **514** on inquiry card.

TEMPERATURE CABINETS. New 4-page Bulletin 2-57 illustrates and specifies 6 different models of sub-zero industrial freezers.—Webber Corp., P. O. Box 217, Indianapolis 6, Ind.

Circle **515** on inquiry card.

TEMPERATURE CONTROLLERS. New 24-page booklet discusses facilities of the company and its pressure and thermostatically operated flow control valves and devices.—Controls Company of America, Schiller Park, Ill.

Circle **516** on inquiry card.



PRESSURE

GAGE ACCESSORIES. New 4-page Catalog 600 describes attachments and accessories for various types of gages, dial thermometers and recorders.—United States Gauge, Div. of American Machine and Metals, Inc., Sellersville, Pa.

Circle **517** on inquiry card.

PRESSURE TRANSDUCER. New 2-page Bulletin describes maker's Model P2G high-pressure transducer available in ranges 0 to 10,000 psig.—Pace Engineering Co., 6914 Beck Ave., North Hollywood, Calif.

Circle **518** on inquiry card.

DIFFERENTIAL TRANSFORMERS. New 24-page Bulletin AA-1A describes the operation of maker's "Linear Variable Differential Transformer" and summarizes the mechanical and electrical features of the basic transducer for force, weight, pressure etc.—Schaevitz Engineering, P. O. Box 505, Camden 1, N. J.

Circle **519** on inquiry card.

PROCESS

STEAM FLOWMETER. New 4-page Data Sheet 463-170 describes the operation of maker's "Centrimax" flowmeter and lists applications in the power field and others where a highly accurate measurement ±0.5% of theoretical maximum flow is required.—Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.

Circle **520** on inquiry card.

GLOSS, VISCOSITY, HUMIDITY INSTRUMENTS. Several pieces of literature are available: "Gardner Laboratory Newsletter," Vol. 4, No. 19 describes maker's automatic gloss recorder; Newsletter, Vol. 4, No. 20 provides data on Ford type viscosity cup and accessories; Newsletter, Vol. 4, No. 21 provides information on company's new fire protection device; new 6-page Folder 1-78 describes new Bausch & Lomb measuring magnifier; new 4-page Bulletin 81-1566 on the

"Bendix Friez" psychrometer.—Gardner Laboratory, Inc., P. O. Box 5728, Bethesda 14, Md.

Circle **521** on inquiry card.

VALVES. New 16-sheet folder presents features of maker's control valves, plug valves, and their use in natural gasoline plants and refineries. —Elsey Corp., Drawer 841, Bartlesville, Okla.

Circle **522** on inquiry card.

FORCE, WEIGHT, ACCELERATION

ACCELEROMETERS AND CALIBRATORS. Two new 2-page Bulletins, AA1 and AA2, provide data on maker's inductive and angular accelerometers; and two new 2-page bulletins describe maker's Model AAC-2 and Model AAC-10 angular accelerometer calibrators.—Statham Development Corp., 12411 West Olympic Blvd., Los Angeles 64, Calif.

Circle **523** on inquiry card.

BALANCES. New 2-page Bulletin A6288 describes the "Sauter" precision balance. 2-page Bulletin 12657 gives data on "Sauter" specific gravity balances.—Boder Scientific Co., 810-814 Penn Ave., Pittsburgh 22, Pa.

Circle **524** on inquiry card.

STRAIN GAGE. New 4-page Bulletin 1.0 presents information on maker's strain gage.—Statham Laboratories, Inc., 12401 West Olympic Blvd., Los Angeles 64, Calif.

Circle **525** on inquiry card.

SCALES. New literature includes: 4-page bulletin describing maker's type "S" motor truck scale; 2-page bulletin providing data on "Contractors' Special" road material scale; 2-page bulletin describing two types of maker's "Uni-Batch" for use with concrete mixers; three bulletins on maker's "Binanbatch," a batch weigher for highway and bridge construction.—Winslow Government Standard Scale Works, North 25th St., Terre Haute, Ind.

Circle **526** on inquiry card.

AIR, WATER, SMOKE

PURIFIERS. New 8-page Bulletin 801 provides information on maker's purifiers which prevent mist carryover from process vessels, remove compressor oil, condensate, etc. from steam, air and gas vapor, etc.—The V. D. Anderson Co., Div. of International Basic Economy Corp., 1935 W. 96th St., Cleveland 2, Ohio.

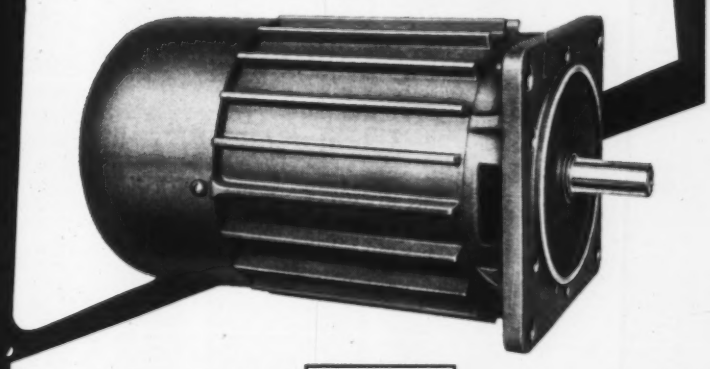
Circle **527** on inquiry card.

FILTERS. New 8-page bulletin illustrates filter industrial applications, including disposable media gravity type, combination gravity and magnetic, straight magnetic, vacuum, pressure and screen-type settling fil-

The Key is
VERSATILITY...

Output (hp)	⅓
Speed (rpm)	3400
Duty	continuous
Field Voltage	70
Field current (amps)	0.470
Armature voltage	230.
Armature full load current (amps)	1.25
Stalled torque (lb. in.)	72.
Armature circuit resistance (ohms)	15.4
Armature circuit inductance (henries)	.0015
Theoretical acceleration at stall (radians/sec.^{2})	25,400
Armature inertia (lb. in.^{2})	1.10
Weight	13.5

The above values are valid for DC operation.



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Note especially the high acceleration constant.

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For more information circle **177** on inquiry card.

NEW LITERATURE

ters for all kinds of liquids.—Industrial Filtration Co., Lebanon, Ind.

Circle **528** on inquiry card.

AIR FILTERS. New 2-page Bulletin IAF-856 specifies maker's new instrument-air filters.—Air-Maze Corp., 25000 Miles Rd., Cleveland 28, Ohio.

Circle **529** on inquiry card.

FEED WATER REGULATOR. New 4-page Bulletin 1028 describes company's new Type P regulator for remote control of boiler feed water in stationary and marine service.—Copes-Vulcan Div., Blaw-Knox Co., Erie, Pa.

Circle **530** on inquiry card.

WATER DEMINERALIZERS. New 6-page brochure describes a new type, all-plastic unit for producing high-purity demineralized water by the ion-exchange method.—Enley Products, Inc., 1236 Broadway, Brooklyn 21, N. Y.

Circle **531** on inquiry card.

AIR FILTERS. New 8-page Bulletin ALC 157 describes and illustrates maker's air and oil filters.—Air-Maze Corp., 25000 Miles Rd., Cleveland 28, Ohio.

Circle **532** on inquiry card.

AIR FILTRATION. New 4-page Bulletin 120 shows comparable efficiencies, based on the three standard tests, of various types of filters, defines high-efficiency filtration and gives basic information on filter selection.—Cambridge Filter Corp., 738 E. Erie Blvd., Syracuse 3, N. Y.

Circle **533** on inquiry card.

COMBUSTION TEST KIT. New 4-page Bulletin G-20 describes maker's combustion test kit no. 1100 for tests of CO_2 content, draft, stack temperature, and smoke.—F. W. Dwyer Mfg. Co., P. O. Box 373, Michigan City, Ind.

Circle **534** on inquiry card.

ANALYTICAL, LABORATORY

ANALYTICAL INSTRUMENTS. New 4-page Bulletin 138 provides condensed information on photoelectric and electronic measuring instruments manufactured by Photovolt.—Boder Scientific Co., 810-814 Penn Ave., Pittsburgh 22, Pa.

Circle **535** on inquiry card.

SPECTROMETER. New 8-page bulletin covers manufacturer's new "E-P-R" (Electron Paramagnetic Resonance) Spectrometer.—Varian Associates, Instrument Div., Palo Alto, Calif.

Circle **536** on inquiry card.

VACUUM SPECTROGRAPH. New 8-page issue of "Jaco News Letter" (Vol. 2, No. 4) features maker's 6.8 Meter Grazing Incidence Vacuum Spectrograph.—Jarrell-Ash Co., 26 Farwell St., Newtonville 60, Mass.

Circle **537** on inquiry card.

LAB GLASSWARE. New 234-page Catalog TG-15 contains description and prices of 11,130 items of laboratory and scientific glassware.—Kontes Glass Co., Vineland, N. J.

Circle **538** on inquiry card.

PLASTIC FITTINGS. New 2-page data sheet describes maker's new line of insert-type polyethylene fittings and pipe for use with polyethylene sink traps.—Arthur S. LaPine & Co., 6001 S. Knox Ave., Chicago 29, Ill.

Circle **539** on inquiry card.

LABORATORY PUMP. New 2-page bulletin describes maker's new small-capacity "Sigmamotor" pump.—Schaar and Co., 754 West Lexington St., Chicago 7, Ill.

Circle **540** on inquiry card.

GAMMA-RAY SPECTROMETERS. New 4-page "RCL Counter", Vol. 2 No. 10, describes maker's medical spectrogammeometer, and the bench-type spectrogammeometer.—Radiation Counter Lab., Inc., Nucleonic Park, 5122 W. Grove St., Skokie, Ill.

Circle **541** on inquiry card.

SPOT EVALUATOR. New 4-page bulletin describes and illustrates maker's new Model 157 for spot evaluation on paper tape.—Research Appliance Co., Box 307, Allison Park, Pa.

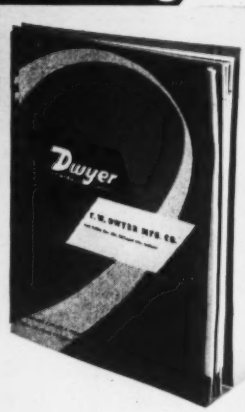
Circle **542** on inquiry card.

METAL ANALYSES. New 4-page Bulletin 13 lists services available and prices for chemical analysis and physical tests of alloys, minerals, ores and scrap.—Crippen & Erlich Lab., Inc.,

NEW 72-page GAGE and CONTROL Catalog

..tells where to use them..

..WHY and HOW!



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- Simple in design
- Ruggedly built
- Free from continuously moving parts—except for chart drive
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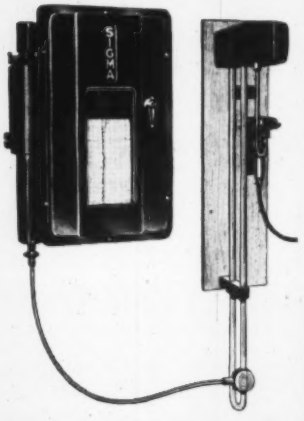

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Subsidiary of Foster D. Snell, Inc., 1138 E. North Ave., Baltimore 2, Md.
Circle **543** on inquiry card.

LABORATORY EQUIPMENT. New 20-page catalog presents company's line of "Jena" laboratory glassware, and "Haldenwanger" porcelainware.—Kern Laboratory Supply Co., 8639 Venice Blvd., Los Angeles 34, Calif.
Circle **544** on inquiry card.

DATA HANDLING

VOLTAGE SCALE CHECK. New 2-page Technical Data Sheet 115 describes REAC Voltage Scale Check Chassis used as minimum excursion indicator in analog computation.—Reeves Instrument Corp., 215 E. 91st., St., New York 28, N. Y.
Circle **545** on inquiry card.

UNIVAC SCIENTIFIC. New 12-page Booklet LSC provides information on the Univac Scientific electronic computing system, Model 1103A and its applications.—Remington Rand Univac, Div. of Sperry Rand Corp., 1902 W. Minnehaha Ave., St. Paul W4, Minn.
Circle **546** on inquiry card.

DIGITAL COMPUTER. New 4-page Bulletin 508-T describes maker's portable "Recomp", a general purpose, all transistor, digital computer.—Autonetics Div of North American Aviation, Inc., 9150 E. Imperial Highway, Downey, Calif.
Circle **547** on inquiry card.

COMPUTING INDICATOR. New 2-page leaflet outlines features of maker's new computing digital indicator, Model DY-2500.—Dynac, Inc., A Subsidiary of Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.
Circle **548** on inquiry card.

MAGNETIC TAPES. New 4-page Bulletin DMF-4 provides information on applications, mechanical, physical and magnetic properties, and other helpful data on maker's silicon iron magnetic tapes.—Thomas & Skinner, Inc., 1164 E. 23rd St., Indianapolis 7, Ind.
Circle **549** on inquiry card.

STORAGE MATRICES. New 2-page leaflet provides data on company's magnetic storage matrices.—Telemeter Magnetics, Inc., 2245 Pontius Ave., Los Angeles 64, Calif.
Circle **550** on inquiry card.

COMPUTER. New 4-page Bulletin 3C-PAC/3 contains data on company's "building block" assemblies of logical systems.—Computer Control Company, Inc., Wellesley, Mass.
Circle **551** on inquiry card.

COMPUTING EQUIPMENT. New 4-page Bulletin CPR-101 discusses analog installations from maker's line of consols, expansion racks, and components for each computation requirement.—Electronic Associates, Inc., Long Beach, N. J.
Circle **552** on inquiry card.

COUNTER. New 2-page Bulletin G 1, printed in English, French, Spanish

you can't afford to "do it yourself"

Where custom systems are involved, it just doesn't pay to do the work yourself. Not when EECO can do it for you—expertly, efficiently—without disrupting the normal productive activities of your engineering staff. Major EECO installations in operation in all parts of the country are proof of Electronic Engineering Company's ability to design and produce anything from single-rack recording systems to the most complex multi-console master installations. And EECO design techniques, perfected through years of systems work, are now ready to be put to work for you in an EECO engineered system to meet your exact requirements.

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For more information circle **180** on inquiry card.

NEW LITERATURE

and German, describes Swiss-made predetermining counter Z9060/Z9060 ED.—Victor George Herman, 311 W. 97th St., New York 25, N. Y.

Circle **553** on inquiry card.

ANALOG COMPUTER. New 4-page bulletin describes maker's "Mac", an inexpensive electronic analog computor.—Automation Service Co., 2123 Outpost Drive, Hollywood 28, Calif.

Circle **554** on inquiry card.

PUNCHED TAPE. New 28-page booklet provides information on the "Flexowriter" automatic writing machine.—Friden Calculating Machine Co., Inc., 2350 Washington Ave., San Leandro, Calif.

Circle **555** on inquiry card.

TAPE TRANSLATOR. New 8-page bulletin discusses maker's Autograf, Model 50 tape translator.—F. L. Moseley Co., 409 North Fair Oaks Ave., Pasadena 3, Calif.

Circle **556** on inquiry card.

ENCODER. New 2-page bulletin describes maker's "OREAD" optical rotational encoder converting analog data to decimal form.—Cubic Corp., 5575 Kearny Villa Rd., San Diego 11, Calif.

Circle **557** on inquiry card.

SIGNAL GENERATOR. New 2-page Bulletin DS-157 provides information on character display signal generator, Model DS-157, an output device for electronic computers and data processing equipments.—Wang Laboratories, Inc., 37 Hurley St., Cambridge 41, Mass.

Circle **558** on inquiry card.

MAGNETIC HEADS. New 4-page Bulletin MO-58, Rev. 3 describes maker's precision-mounted Read/Record head for use in special applications of magnetic drum information storage.—Monroe Calculating Machine Co., Electronics Div., Morris Plains, N. J.

Circle **559** on inquiry card.

PRODUCTION COUNTERS. New 8-page catalog describes different models of maker's production counters.—R. E. Hart Mfg. Co., 940 N. Main St., Ann Arbor, Mich.

Circle **560** on inquiry card.

RECORDERS

GALVANOMETER RECORDER. New 6-page Bulletin R-502 gives specifications and features of company's "DU-AL recti/riter", a new two-channel rectilinear galvanometer recorder which records two functions on two full 4-½" scales on one chart.—Texas Instructions Inc., Industrial Instrumentation Div., 3609 Buffalo Speedway, Houston, Tex.

Circle **561** on inquiry card.

RECORDING SYSTEMS. New 6-page Folder ED 21720 covers maker's direct-writing recording systems of oscillographs, amplifiers, and accessories.—Brush Electronics Co., Div. of Clevite Corp., 3405 Perkins Ave., Cleveland 14, Ohio.

Circle **562** on inquiry card.

RECORDING SYSTEMS. Four new 2-page bulletins describe company's "Mincom" wide-band magnetic tape recorder and Models "Minban," "Minsig," and "Minair" magnetic tape systems.—Mincom Division, Minnesota Mining & Manufacturing Co., 9028 Sunset Blvd., Los Angeles 46, Calif.

Circle **563** on inquiry card.

RECORDING TAPE. New 30-page booklet, "The 7 Old-Fashioned Villains of Tape Recording . . . and How They Were Foiled," humorously presents the advantages of maker's "Irish Ferro-Sheen" tape for every recording requirement.—ORRadio Industries, Inc., Opelika, Ala.

Circle **564** on inquiry card.

ELECTRODYNAMIC RECORDERS. New 2-page bulletin offers information on maker's Model GA-1023 direct inking, 2 channel recorder.—New 4-page article reprint describes the same recorder, in addition to giving information on a pen motor for rectilinear recording.—Massa Laboratories, Inc., Hingham, Mass.

Circle **565** on inquiry card.

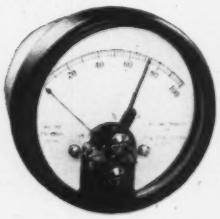
VIBRATION

VIBRATION INSTRUMENTS. New 24-page Catalog ED 11501 illustrates and describes a complete line of Bruel & Kjaer instruments for sound, strain and vibration measurements.—Brush

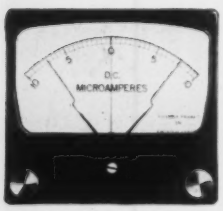
METER-RELAYS

D'Arsonval indicating meters with built-in locking contacts for sensitive and accurate control or alarm

TRIP POINT ADJUSTABLE to any point of scale arc. Sensitive to changes as little as 1%. One contact carried on moving pointer. The other on an adjustable pointer. When two pointers meet, contacts close and lock. Holding coil is wound directly over moving coil, locking action is electro-magnetic. Reset can be manual or automatic. Spring action in contacts kicks them apart forcefully.



Model 255-C, Single Contact, High Limit, 0-10 Volts DC $42.50



Model 461-C, Double Contact 10-0-10 Microamps DC $83.25

Ranges from 0-5 microamperes or 0-5 millivolts up, full scale. Temperature ranges from 0-300°F. (10 ohms external) have bimetal cold junction compensation. **Standard Contact Rating** 5 to 25 milliamperes DC. Can be built up to 100 milliamperes DC.

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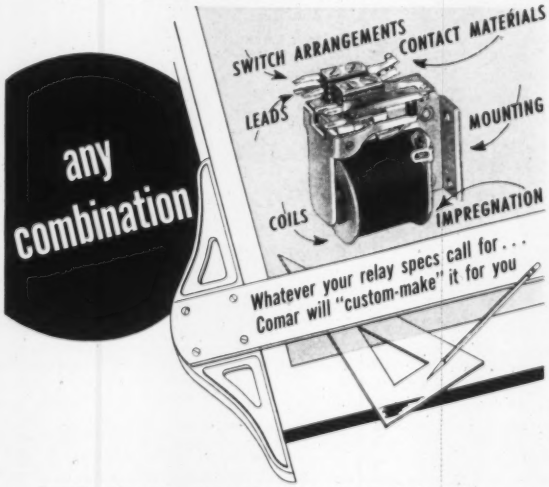
Booth 1323, Design Engineering Show, May 20-23, Coliseum, NYC

For more information circle **181** on inquiry card.



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Electronics Co., Div. of Clevite Corp., 3405 Perkins Ave., Cleveland 14, Ohio.

Circle **566** on inquiry card.

VIBRATION TESTING. New 2-page Bulletin A-14-28-5659 describes maker's vibration testing machine Model 14-28.—The Ahrendt Instrument Co., College Park, Md.

Circle **567** on inquiry card.

VIBRATION MEASUREMENT. New 18-page Catalog WO 5-6140 describes maker's displacement followers (and power supply units) for measuring displacement, runout, or vibration of mechanical parts.—Optron Corp., 3526 State St., Santa Barbara, Calif.

Circle **568** on inquiry card.

VIBRATION TESTING. New 4-page bulletin provides information on electronically driven vibration testing systems.—Ling Electronics Inc., 5120 W. Jefferson, Los Angeles, Calif.

Circle **569** on inquiry card.

VIBRATION TEST SYSTEMS. New 6-page Bulletin 17400 describes new series 174 wide-band shaker, basic for maker's 6 different vibration test systems up to 1500 lb force output.—The Calidyne Co., Winchester, Mass.

Circle **570** on inquiry card.

SHAKER SYSTEMS. New 6-page Bulletin 17700 describes new series 177 shaker systems for vibration tests up to 5000 lb force output and 411 lb load at 10 G.—The Calidyne Co., 120 Cross St., Winchester, Mass.

Circle **571** on inquiry card.

GAGING, TESTING

GAGING AND CONTROL. Four new 2-page bulletins are available on maker's new line of gauging and control equipment: Bulletin A-1 and A-2 describe electronic gaging and control equipment; Bulletin B-1 and B-2 cover electronic measuring units; Bulletin C-1 and C-2 specify gage heads; Bulletin D-1 and D-2 deal with electrical accessories for measurement and control.—Airborne Instruments Laboratory, Inc., 160 Old Country Rd., Mineola, N. Y.

Circle **572** on inquiry card.

TEST EQUIPMENT. New 6-page Bulletin 2058 contains up-to-date listings of equipment for servicing television, radio, and industrial electrical equipment as well as refrigeration and air-conditioning appliances, and heating equipment.—Simpson Electric Co., 5200 W. Kinzie St., Chicago 44, Ill.

Circle **573** on inquiry card.

TEST EQUIPMENT. New 20-page booklet provides information on Cal-Tronics Corp. which offers complete services for military and commercial test instrumentation.—Cal-Tronics Corp., 11307 Hindry Ave., Los Angeles 45, Calif.

Circle **574** on inquiry card.

TEST EQUIPMENT. New 4-page Bulletin 356-2 provides information on maker's new line of precision electronic test equipment.—New London Instrument Co., Inc., 82 Union St., New London, Conn.

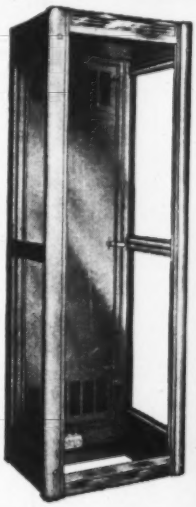
Circle **575** on inquiry card.

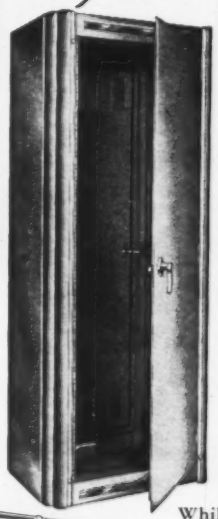
NEW — UNIVERSAL CABINET RACKS

PAR-METAL ELECTRONIC HOUSINGS

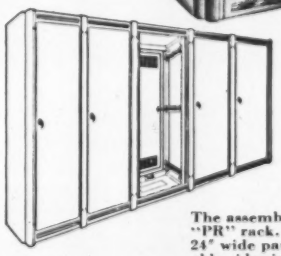
WITH OPEN SIDES AND DETACHABLE SIDE PANELS

Adaptable TO GROWTH REQUIREMENTS





The above unit is our Type "PR" (with rear door only) "Universal Cabinet Rack." Type "FR" (shown with detachable side panels *affixed*) has both front and rear doors.



PAR-METAL Types "PR" and "FR" Universal* Cabinet Racks are made with *Detachable Side Panels* in order to assure flexibility for your future needs.

Because these are STANDARD UNITS, you get custom-quality at economical cost. They may be used *singly* or in a *group arrangement.*

Made in these dimensions:

Heights: 48 1/8", 67 3/8", 76 1/8" and 83 1/8".
Depths: 18" and 24".
Panel Widths: 19" and 24".

Built for Dependable Service

While incorporating new features of versatile assembly, there has been no sacrifice of *structural rigidity.* ALL PAR-METAL RACKS *are substantially welded* and *reinforced* for diversified industrial use.

STANDARD ACCESSORIES: Vertical Side Supports, Sliding Shelves, Rack Mounting Chasses, Bases, Roller Trucks, etc., are available as standard equipment.

The assembly of 5 racks shown at left has 4 Type "FR" and 1 Type "PR" rack. Equal height racks may be intermixed with 19" and 24" wide panels. The end panels of the assembly have the detachable sides installed. They are quickly removable.

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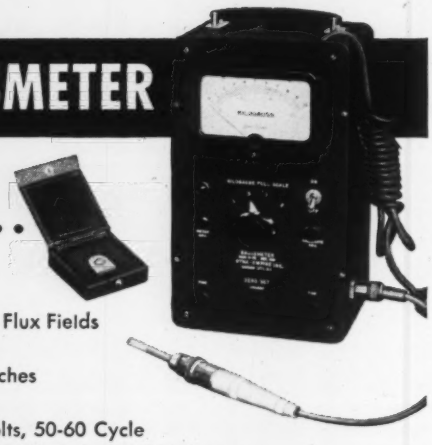
D-79 GAUSSMETER



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- Probe is only .025" thick
- Active area .01 square inches
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- Overall size 13" high, 10-1/2" wide, 6-3/4" deep

Precision built to give accurate flux density measurement and determine "flow" direction. The unit also locates and measures "stray fields," plots variations in strength, and is ideal for checking production lots against a standard. Simple to operate, the D-79 gives no ballistic reading . . . doesn't jerk or pull. Comes in protective carrying case.

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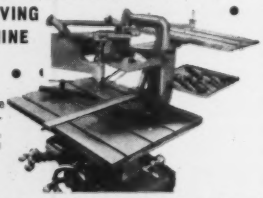

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★ Acid resistant
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NEW LITERATURE

FATIGUE TESTING. New 2-page Bulletin contains information on maker's Ivy-02 multi-range fatigue testing machine featuring a dead-weight static force system.—The Ivy Co., Norwalk, Conn.

Circle **576** on inquiry card.

MICROSCOPE. New 4-page Bulletin describes the Carl Zeiss Interference Microscope specifically designed for convex spherical and cylindrical surfaces.—Ercona Corp., 551 Fifth Ave., New York 17, N. Y.

Circle **577** on inquiry card.

TUBING, PIPE FITTINGS

PLASTIC TUBING. New 4-page folder describes maker's "Nylaflow" pressure tubing, a flexible tubing for air, gases or liquids.—The Polymer Corp. of Penna., Reading, Pa.

Circle **578** on inquiry card.

TUBING. New 14-page Brochure CF-2 discusses maker's production facilities, services and various types of steel tubing offered.—Ohio Seamless Tube Div., Copperweld Steel Co., Shelby, Ohio.

Circle **579** on inquiry card.

FLEXIBLE CONNECTORS. New 2-page Bulletin 158 describes and illustrates flexible connectors used for pumping installations.—Flexonics Corp., 1315 S. Third Ave., Maywood, Ill.

Circle **580** on inquiry card.

HOSE AND FITTINGS. New 12-page Bulletin 182 contains information on maker's industrial hose and fittings.—Aeroquip Corp., Jackson, Mich.

Circle **581** on inquiry card.

STEAM-TRACED PIPE. New 6-page illustrated Bulletin AD-418 describes features of maker's steam-traced pipes.—Aluminum Co. of America, Pittsburgh 30, Pa.

Circle **582** on inquiry card.

PIPE CLAMPS. New 2-page Catalog PP-1256 contains general specifications and descriptive data on "Sure-Tite" stainless steel clamps for plastic pipe.—Wittek Mfg. Co., 4305-37 W. 24th Place, Chicago 23, Ill.

Circle **583** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

ELECTRONIC INSTRUMENTS. New 20-page Issue 1 of "Du Mont Instrument Journal" features articles on company's line of oscilloscopes, pulse generators, preamplifiers, etc.—Allen B. Du Mont Laboratories, Inc., Technical Products Division, 760 Bloomfield Ave., Clifton, N. J.

Circle **584** on inquiry card.

SERVO ANALYZER. New 12-page Bulletin ED 41201 illustrates and de-

scribes the Brush servo analyzer used for complete analysis of control systems.—Brush Electronics Co., Div. of Clevite Corp., 3405 Perkins Ave., Cleveland 14, Ohio.

Circle **585** on inquiry card.

VARIABLE-SPEED DRIVE. New 4-page Bulletin S 790 provides general specifications and engineering data on company's "Magne-Speed Junior" non-electronic variable speed drives, Model MS-6500.—Magnetic Amplifiers Inc., 632 Tinton Ave., New York 55, N. Y.

Circle **586** on inquiry card.

INSTRUMENT TRANSFORMER. New 90-page Buyer's Guide GEC-1028B, contains price and product information on General Electric's complete instrument transformer line.—General Electric, Instrument Dept., Lynn, Mass.

Circle **587** on inquiry card.

TRANSITOR TESTER. New 2-page Bulletin TP106-1 contains information on maker's tester for measurement of basic transistor characteristics.—Baird-Atomic, Inc., 33 University Rd., Cambridge 38, Mass.

Circle **588** on inquiry card.

A-C, D-C VOLTMETERS. New 4-page Data Sheet 875 lists and describes 126 standard models of Beckman expanded scale a-c, and d-c voltmeters.—Beckman/Helipot Corp., Newport Beach, Calif.

Circle **589** on inquiry card.

TIME BROADCAST. New 12-page Data File 10 describes function, applications and recent improvements of National Bureau of Standards radio stations WWV and WWVH.—Shasta Div. Beckman Instruments, Inc., P. O. Box 296, Station A, Richmond, Calif.

Circle **590** on inquiry card.

TRANSISTORIZED INSTRUMENTS. New 4-page Bulletin 9035 contains specifications on a complementary new line of transistorized oscillators, etc.—Kay Electric Co., 14 Maple Ave., Pine Brook, N. J.

Circle **591** on inquiry card.

ELECTRONIC INSTRUMENTS. New 4-page issue of "Keithley Engineering Notes," Vol. 5 No. 1 provides information on five new micro-microammeters which include ultra stable, contact meter, and logarithmic models. New 2-page Vol. 5 No. 2, discusses new transistorized electrometer model 220 DC VTVM which combines electrometer input with transistor amplifier, and has 1 mv to 20 kv range.—Keithley Instruments, Inc., Cleveland 6, Ohio.

Circle **592** on inquiry card.

TRANSISTOR CURVE TRACER. New 4-page Bulletin S383A contains information on maker's transistor curve tracer, Model 200A; new 4-page Bulletin S667 covers Model 300A for power transistors.—Magnetic Amplifiers, Inc., 632 Tinton Ave., New York 55, N. Y.

Circle **593** on inquiry card.

OSCILLOSCOPE. New 4-page Bulletin discusses maker's new "Memo-Scope" oscilloscope, a "memory" tube instrument, which makes photograph-

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Valves run to 6" diam. and up, with very high pressures and flow rates, extremely rapid action, temperatures down to −300°F. You'll guide the shopwork—most of the components are too unusual for outside suppliers.

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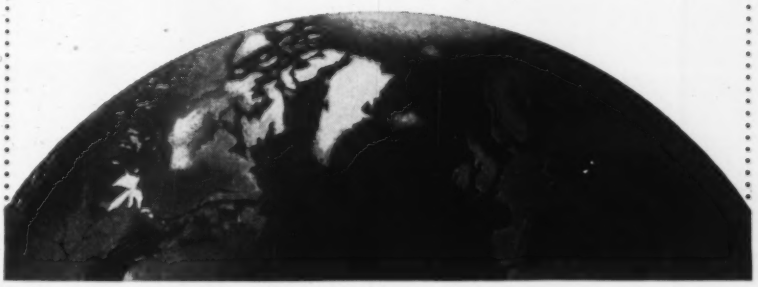

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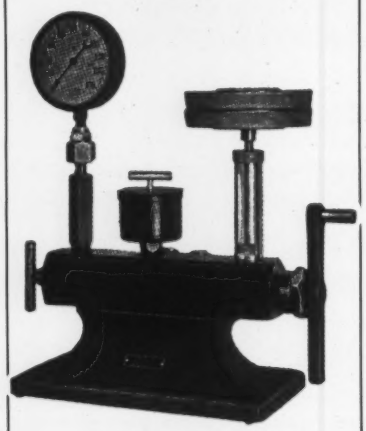
AMTHOR Dead Weight Pressure Gauge TESTER



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For more information circle **189** on inquiry card.

NEW LITERATURE

ing unnecessary.—Hughes Aircraft Co., International Airport Station, Los Angeles 45, Calif.

Circle **594** on inquiry card.

PULSE CALIBRATOR. New 4-page brochure describes maker's new Type 1810 pulse calibrator, designed for accurately measuring current and voltage pulse amplitudes, pulse durations and rise time.—Burroughs Corp., Electronic Instruments Div., 1209 Vine St., Phila. 7, Pa.

Circle **595** on inquiry card.

ELECTRONIC EQUIPMENT. New 4-page short form catalog describes precision electronic equipment, including phasemeter, impedance comparators, power oscillators, etc.—Industrial Test Equipment Co., 55 East 11th St., New York 3, N. Y.

Circle **596** on inquiry card.

SWEEP GENERATORS. New 12-page Brochure 9522, (and 2-page bulletin), give information on maker's portable sweep generators Models 95 and 220, with an all electronic sweep circuit.—New 24-page Brochure 1900 (and 2-page bulletin) give information on sweep generator Model 900.—Jerrold Electronics Corp., 23rd and Chestnut Sts., Phila. 3, Pa.

Circle **597** on inquiry card.

AMPLIFIERS. New 2-page Bulletin 563 gives data on company's amplifier Model UBC-26 for closed-circuit television.—New 2-page Bulletin 565 describes company's oscilloscope preamplifier Model SPR-100 for use with sweep generators and oscilloscopes.—Jerrold Electronics Corp., 23rd and Chestnut Sts., Phila. 3, Pa.

Circle **598** on inquiry card.

COAXIAL SWITCHES. New 2-page Bulletin 564 describes maker's coaxial switch Model FD-30 for the simultaneously display of two channels or voltages on an oscilloscope.—New 2-page Bulletin J-FD30 describes maker's Model CS-754 mechanical coaxial switch for laboratory use.—Jerrold Electronics Corp., 23rd and Chestnut Sts., Phila. 3, Pa.

Circle **599** on inquiry card.

VOLTAGE DIVIDERS. 3 new 2-page bulletins describe maker's Models 302 and 303 sealed, shaft-driven precision a-c voltage dividers.—Gertsch Products, Inc., 11846-48 Mississippi Ave., Los Angeles 25, Calif.

Circle **600** on inquiry card.

TRANSISTOR AMPLIFIER. New 2-page Bulletin P-5702 describes maker's Model 196, 90-db transistor amplifier designed for servo and audio applications.—Taber Instrument Corp., 111 Goundry St., North Tonawanda, N. Y.

Circle **601** on inquiry card.

DC AMPLIFIER. New 2-page leaflet describes the new solid-state model 71 differential DC amplifier which is entirely transistorized.—Video Instruments Co. Inc., 2340 Sawtelle Blvd., Los Angeles 64, Calif.

Circle **602** on inquiry card.

ELECTRICAL INSTRUMENTS. Fifteen new 2-page releases are available: Catalogs L 4010, L 4020, L 4030, and L 4040 describe standard and VHF signal generators; Catalog L 4050 offers information on pulse generator, Type LG-30; Catalogs L 1010 and L 1020 review Models LV-14 and LV-15 d-c voltmeters; Catalog L 1005 describes vacuum tube voltmeter, Type LV-10; Catalogs L 3005 and L 3010 cover two models of RF power meters; Catalogs L 2005 and L 2010 contain information about two models of impedance bridges; Catalog L 4080 describes maker's crystal modulator MI-30451; Catalog L 5010 presents multimeter type LM-1; and Catalog L 6000 describes two types of mechanical filters.—Radio Corp. of America, Camden, N. J.

Circle **603** on inquiry card.

POWER RECTIFIERS. New 4-page Bulletin AC-57-R describes different models of maker's manually controlled power rectifiers. New 7-page Bulletin AC-57-A describes features of maker's automatically regulated power rectifiers.—Christie Electric Corp., 3410 W. 67th St., Los Angeles 43, Calif.

Circle **604** on inquiry card.

OSCILLOSCOPE. New 4-page Bulletin 411A describes maker's Model 411A wide-band oscilloscope with six plug-in units that give it great versatility.—Laboratory for Electronics., Inc., 75 Pitts St., Boston 14, Mass.

Circle **605** on inquiry card.

TUBES

APERTURE MASKS. New 4-page Data Memorandum 5, describes maker's new aperture mask for color television tubes.—Superior Tube Co., Norristown, Pa.

Circle **606** on inquiry card.

ELECTRONIC TUBES. New Technical Handbook covers complete line of Swedish-made Ericsson electronic tubes. Included are complete ratings and characteristic curves.—State Labs Inc., 649 Broadway, New York 12, N. Y.

Circle **607** on inquiry card.

SUBMINIATURE TUBES. New 6-page reprint "Radiography in Production Control and Inspection of Subminiature Tubes" describes techniques used by Raytheon Manufacturing Co. —Instruments Div., North American Philips Co., Inc., 750 South Fulton St., Mount Vernon, N. Y.

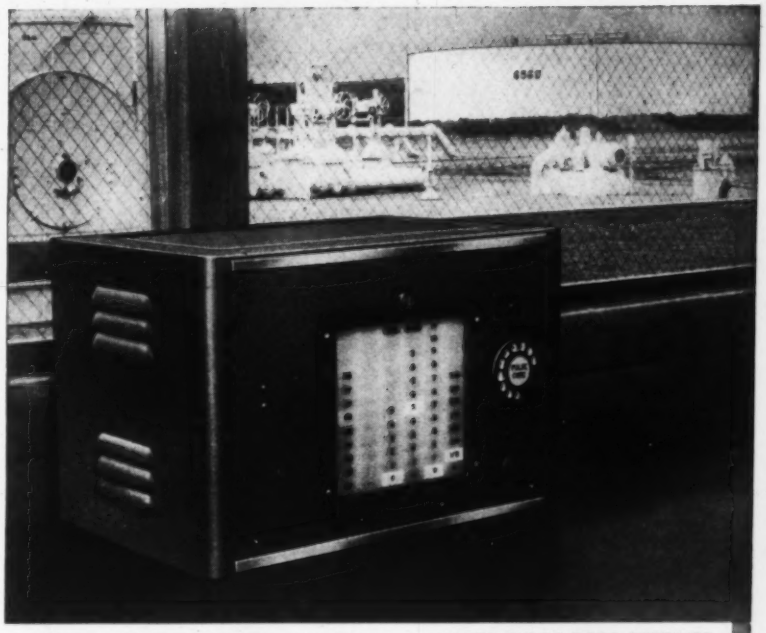
Circle **608** on inquiry card.

SWITCHES, RELAYS

TIME DELAY RELAYS. New 2-page Bulletin AWH TD 406 contains details on the construction of 3 basic time delay relays in new extruded hermetic housings.—The A. W. Haydon Co., Waterbury, Conn.

Circle **609** on inquiry card.

MAGNETIC RELAYS. New 8-page Bulletin 1060 describes a-c and d-c,



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NEW LITERATURE

general purpose magnetic relays.—RBM Div., Essex Wire Corp., Logansport, Ind.

Circle **610** on inquiry card.

ELECTRONIC RELAY. New 8-page Bulletin 1050 describes electronic relays, open and hermetically sealed.—RBM Div., Essex Wire Corp., Logansport, Ind.

Circle **611** on inquiry card.

MICRO SWITCH. New 2-page Data Sheet 117 provides information on buttons for lighted pushbutton switches.—Micro Switch Div. of Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle **612** on inquiry card.

MICRO SWITCHES. New 4-page Bulletin W-2-7 provides information on micro switches for electronic control requirements.—Micro Switch Div., of Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle **613** on inquiry card.

SWITCHES. Two new 2-page data sheets 113 and 119 describe maker's flexible actuator switch and a proximity switch, respectively.—Micro Switch Div. of Minneapolis-Honeywell Regulator Co., Freeport, Illinois.

Circle **614** on inquiry card.

TIME SWITCHES. New 2-page Bulletin 257 describes maker's "Momentary Contact" time switch series for direct automatic control of low-voltage lighting systems and mechanically-held contactors.—Tork Time Controls, Inc., Mount Vernon, N. Y.

Circle **615** on inquiry card.

RESISTORS, POTENTIOMETERS

POTENTIOMETERS. Five new 2-page leaflets are available: Data Sheet 54-07 describes linearity tolerances in the "Helipot" series AJ potentiometer; Data Sheet 54-23 describes linearity tolerances for "Beckman/Helipot" series D and E potentiometers; Data Sheet 54-03 gives life expectancy figures and noise ratings for 1-13/16" dia series A (ten-turn) and C (three-turn) potentiometers. Data Sheet gives similar data on series T. Data Sheet 54-12 provides the latest modification in specifications series AN and CN precision potentiometers.—Beckman/Helipot Corp., Newport Beach, Calif.

Circle **616** on inquiry card.

RESISTORS. New 12-page Bulletin C-1b contains data on maker's tubular and flat Power Wire Wound Resistors.—International Resistance Co., 401 N. Broad St., Phila. 8, Pa.

Circle **617** on inquiry card.

CARBON FILM RESISTORS. New 2-page Catalog 307-1056 describes maker's new low-cost carbon film resistors and provides mechanical and electrical characteristics.—Continental Carbon, Div. of Wirt Co., 5221 Greene St., Phila. 44, Pa.

Circle **618** on inquiry card.

WIRE-WOUND RESISTORS. New 2-page Bulletin CB-2 describes and specifies maker's precision wire-wound resistors.—Kelvin Electric Co., 5907 Noble Ave., Van Nuys, Calif.

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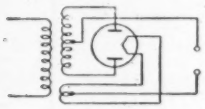

POWER SUPPLIES

POWER SUPPLIES. New 6-page bulletin describes maker's "Com-Pak" series of power supplies.—Lambda Electronics Corp., 11-11 131 St., College Point 56, N. Y.

Circle **620** on inquiry card.

POWER SUPPLIES. New 2-page bulletin outlines features of maker's "Nobatron" group of more than 70 available models.—Sorensen & Co., Inc., 375 Fairfield Ave., Stamford, Conn.

Circle **621** on inquiry card.

BATTERIES. New 16-page booklet, "So You're Going to Buy an Industrial Battery," is designed to help select the most economical and efficient battery.—Gould National Batteries, Inc., Trenton 7, N. J.

Circle **622** on inquiry card.

BATTERY CHARGER. New 2-page Bulletin BC-A-57-1 describes maker's precision controlled, automatic battery charger.—Christie Electric Corp., 3410 W. 67th St., Los Angeles 43, Calif.

Circle **623** on inquiry card.

ELECTRONIC COMPONENTS

CAPACITORS. Three new releases describe different maker's capacitors: 2-page Bulletin 533 covers "Electromite" subminiature aluminum foil electrolytic capacitors; 2-page Bulletin 152-1 provides data on high temperature bathtub metallized-paper capacitors; and 4-page Bulletin 172 reviews maker's "Quietone" feed-through suppression capacitors.—Cornell-Dubilier Electric Corp., South Plainfield, N. J.

Circle **624** on inquiry card.

MINIATURE LIGHTS. New 20-page catalog provides information on various classes of miniature lighting equipment available from maker.—Drake Mfg. Co., 1713 W. Hubbard St., Chicago 22, Ill.

Circle **625** on inquiry card.

DELAY LINES. New 4-page Bulletin 17 provides information on applications, specifications, electrical and mechanical characteristics, of maker's high-impedance delay lines with magnetic core.—Columbia Technical Corp., 61-02 31st Ave., Woodside 77, N. J.

Circle **626** on inquiry card.

HEATING ELEMENTS. New 12-page Booklet A-1472 covers important information on handling, unpacking, storage, installation and replacement of silicon carbide elements.—Globar Div., The Carborundum Co., Hyde Park Blvd., Niagara Falls, N. Y.

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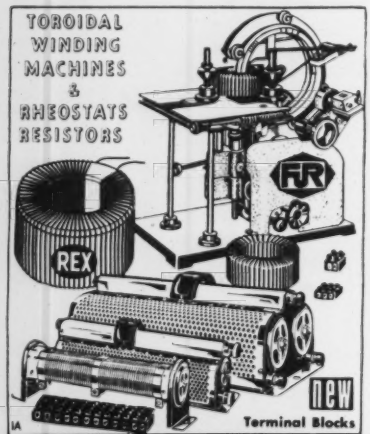

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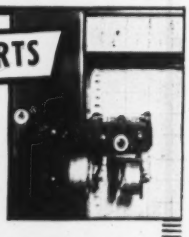

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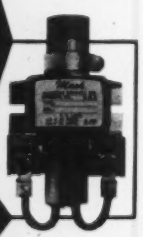

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NEW LITERATURE

COUNTING CIRCUITS. New 4-page Catalog 11437 describes company's transistorized plug-in counting circuits for subminiaturization.—Walkirt Co., 141 Hazel St., Inglewood, Calif.

Circle **628** on inquiry card.

CARBON COLLECTORS. New 4-page bulletin describes three main types of maker's carbon current collectors, the 3Z, 3V and 3U series.—Morganite Inc., 3302-3320 Forty-eighth Ave., Long Island City 1, N. Y.

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WIRE

HOOK-UP WIRES. Two new 2-page leaflets provide information on Series "100" and Series "110" wire with Teflon insulation.—Philadelphia Insulated Wire Co., 200 North Third St., Phila. 6, Pa.

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NEW LITERATURE

INSULATION. New 2-page leaflet describes company's newly developed bonded fiberglas insulation on thermocouple wire or thermocouple extension wire.—Claud S. Gordon Co., 3000 S. Wallace St., Chicago 16, Ill.

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MECHANICAL, ELECTROMECHANICAL COMPONENTS

BREADBOARD PARTS. New 24-page Catalog 575 describes maker's line of standard parts used for servo prototypes or setting up test systems.—Beckman/Helipot Corp., Newport Beach, Calif.

Circle **632** on inquiry card.

BALL BEARINGS. New 2-page leaflet lists maker's new ball bearings number 814 (bore 0.2500", O.D. 0.5000") in series C, FC, CH, FCH, CHH, and FCHH.—Miniature Precision Bearings, Inc., Precision Park, Keene, N. H.

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BALL BEARINGS. New 18-page Booklet MB describes and specifies maker's new miniature ball bearings.—New Departure Div. of General Motors Corp., Bristol, Conn.

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BALL BEARINGS. New 4-page catalog presents price list of maker's products.—Miniature Precision Bearings, Inc., Keene, N. H.

Circle **635** on inquiry card.

SCREW MACHINE PRODUCTS. New 2-page Bulletin A-57 describes maker's beryllium copper screw machine products.—Instrument Specialties Co., Inc., 232 Bergen Blvd., Little Falls, N. J.

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PLASTIC COMPONENTS. New 4-page booklet describes mechanical and electronic components precision-machined from industrial plastics.—Tri-Point Plastics, Inc., Albertson, L.I., N. Y.

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LIQUID SEALANT. New 4-page bulletin describes properties and application of maker's "Loctite Sealant" for threaded fasteners.—American Sealents Co., 103 Woodbine St., Hartford 6, Conn.

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STAINLESS FASTENERS. New 2-page flyer is supplement to maker's regular catalog, listing miniaturized stainless steel screws, nuts and washers in sizes #0, #00 and #C00.—Albany Products Co., Inc., Connecticut Ave., So. Norwalk, Conn.

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NEW LITERATURE high-intensity induced roll electro- **COIL WINDERS,** New 2-page catalog

NEW LITERATURE

plastics for electronics: the 13-sheet "blue brochure" covers microwave absorbers, the 17-sheet "yellow brochure," casting resins, the 14-sheet "green brochure," plastic foams, the 4-sheet "orange brochure," the Ecco reflector lens, the 13-sheet "buff brochure," plastic rods and sheet.—Emerson & Cuming, Inc., 869 Washington St., Canton, Mass.

Circle 640 on inquiry card.

CLAD-METALS. New 4-page Technical Data Bulletin CM-901 contains chart showing at a glance the major types of clad metals available, their design, engineering functions, and applications.—American Silver Company, Inc., 36-07 Prince St., Flushing 54, N. Y.

Circle 641 on inquiry card.

BONDING AGENTS AND SOLVENT. Several new releases are available: 2-page bulletins describe maker's bonding agents "R-323 and R-324," developed to bond nylon; new 4-page bulletin provides data on bonding agent "R-385," a new metal adhesive; new 4-page bulletin specifies bonding agent "R-390," a resin adhesive which will cure at room temperature; new 2-page bulletin discusses company's new releasing agent; and new 2-page bulletin provides data on solvent "101."—Carl H. Biggs Co., Inc., 2255 Barry Ave., Los Angeles 64, Calif.

Circle 642 on inquiry card.

ADHESIVES, COATINGS, SEALERS. New industrial materials selection chart gives application and descriptive information on adhesives, coatings, and sealers.—Miracle Adhesive Corp., P. O. Box 466, New Philadelphia, Ohio.

Circle 643 on inquiry card.

SEMICONDUCTORS. New 2-page Catalog 56A-2 provides information on available discs, pellets, washers, wire etc. of metals and alloys for semiconductor field. Includes chart of physical properties of pure elements, and periodic chart.—Anchor Metal Co., Inc. 966 Meeker Ave., Brooklyn 22, N. Y.

Circle 644 on inquiry card.

FABRICATION

STEEL PRODUCTS. New 232-page catalog describes over 700 products available from stock at company's warehouses.—Engineering Service Dept., Crucible Steel Co., of America, Box 1558, Pittsburgh 30, Pa.

Circle 645 on inquiry card.

METAL REMOVAL. New 8-page brochure describes "Maximum Automation Potential," a new service provided for a new method to predict performance of abrasive belts on any metal removal operation in advance.—The Carborundum Co., P. O. Box 477, Niagara Falls, N. Y.

Circle 646 on inquiry card.

WELDING POSITIONERS. New 16-page Bulletin UB57 features maker's "Universal Balance Positioner" for

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NEW LITERATURE

weld piece positioning.—Aronson Machine Co., Arcade, N. Y.

Circle 647 on inquiry card.

DISPERSIONS. New 4-page Bulletin 2208 lists 44 colloidal and semi-colloidal lubricant dispersions of graphite, molydeenum disulfide, mica, vermiculite, zinc oxide, acetylene black, copper, and glass.—Acheson Colloids Co., Port Huron, Mich.

Circle 648 on inquiry card.

AUTOMATIC BRAZING. New 4-page brochure describes and illustrates maker's "Braze-O-Matic" equipment that automatically performs up to 10 brazings in one operation.—Castle Machines, Inc., 1049 E. 20th St., Erie, Pa.

Circle 649 on inquiry card.

MAGNETIC SEPARATOR. New 2-page Bulletin MB-103 illustrates and covers design, capacity and application details for maker's Model M12 high-intensity induced roll electromagnetic mineral separator.—Carpco, Jacksonville, Fla.

Circle 650 on inquiry card.

SAMPLE SPLITTERS. New 2-page Bulletin SSB-103 provides data on maker's three standard model machines designed for sampling materials which segregate easily.—Carpco Mfg., Inc., Jacksonville 6, Fla.

Circle 651 on inquiry card.

CHROMALLIZING. New 4-page Bulletin 21 describes and illustrates company's patented process for surface alloying of steel by diffusion.—Chromalloy Corp., 450 Tarrytown Rd., White Plains, N. Y.

Circle 652 on inquiry card.

COIL WINDING EQUIPMENT. New 62-page Catalog 57 illustrates and describes 48 coil winding machines of which 18 are newly developed models.—Geo. Stevens Mfg. Co., Inc., Pulaski Rd. at Peterson, Chicago 30, Ill.

Circle 653 on inquiry card.

COIL WINDERS. New 2-page catalog provides technical details on maker's four models hand coil winders.—Geo. Stevens Mfg. Co., Inc., Pulaski Rd. at Peterson, Chicago 30, Ill.

Circle 654 on inquiry card.

BRAZING ALLOYS. New 4-page Catalog SD-23 describes the "Nicrobraz" family of high temperature brazing alloys for stainless steels and special alloys.—Stainless Processing Div., Wall Colmonoy Corp., 19345 John R. Street, Detroit 3, Mich.

Circle 655 on inquiry card.

METALLIZING POWDER. New 2-page Data Sheet 53 discusses use of "Colmonoy C-250" metallizing powder for spray-welding of crankshaft bearing surfaces.—Wall Colmonoy Corp., 19345 John R St., Detroit 3, Mich.

Circle 656 on inquiry card.

STAGING FIXTURES. New 8-page booklet describes and illustrates standard part holders and end stops.—Optical Gaging Products, Inc., 26 Forbes St., Rochester, N. Y.

Circle 657 on inquiry card.

METAL PRODUCTS. New 4-page bulletin provides information on company's custom-built sheet metal products.—The Riester & Thesmacher Co., 1520 West 25th St., Cleveland 13, Ohio.

Circle 658 on inquiry card.

MARKING DEVICES. New 7-page reprint "Meaningful Marks" discusses and illustrates company's machines for marking different products.—The Acromark Co., 9-13 Morrell St., Elizabeth 4, N. J.

Circle 659 on inquiry card.

PLASTICS. New 8-page Bulletin 51156 describes company's equipment for welding thermoplastic materials.—American Agile Corp., P. O. Box 168, Bedford, Ohio.

Circle 660 on inquiry card.

METAL FRAMES. New 16-page brochure gives information about company's "Unistrut" system for constructing any type of metal framing structure.—Unistrut Products Co., 933 W. Washington Blvd., Chicago 7, Ill.

Circle 661 on inquiry card.

ILLUMINATION. New 4-page Folder H257-5M describes the Type B Hinelight, an illuminating device used industrially to produce "maximum information" photographs.—Hinelight Corp., 2538 John St., Fort Wayne, Ind.

Circle 662 on inquiry card.

LUBE SPRAYER. New 8-page bulletin provides information on maker's "Versatal" gear spray equipment for gear lubricant.—Stewart-Warner Corp., 1826 Diversey Parkway, Chicago 14, Ill.

Circle 663 on inquiry card.

ULTRASONIC CLEANING. New 8-page "Metal Digest" (Vol. 3 No. 1) presents news of interest to the metallurgical industry, including articles on ultrasonic cleaning and film-negative development.—Buehler, Ltd., 2120 Greenwood St., Evanston, Ill.

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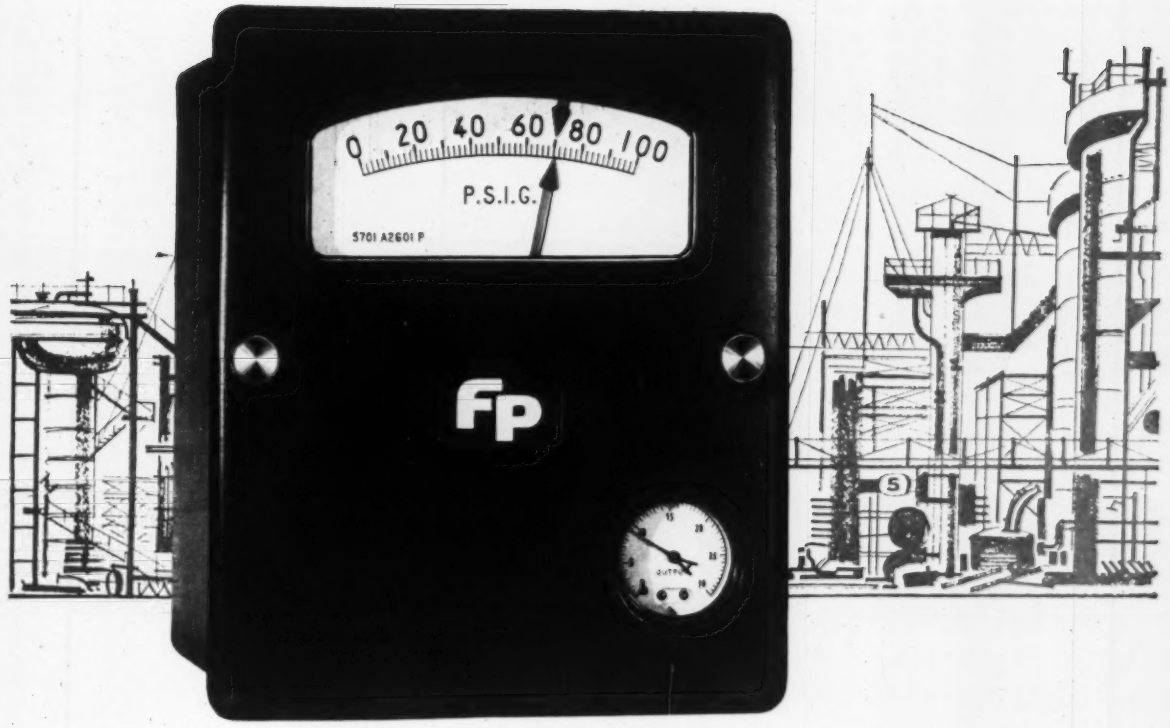

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